Journal of the Society of Arts.

FRIDAY, APRIL 1, 1859.

EXHIBITION OF 1861.

The following summary of information, bearing upon the Exhibition of 1861, has been drawn up by a correspondent :—

Institution of Decennial Exhibitions.

The progress of the Society of Arts, from the time of its foundation to the present, has been marked by a succession of Exhibitions, the nature, scale, and object of which have varied and extended, and gained importance and public support, as Arts, Manufactures, and Commerce have advanced and flourished, from the smallest beginnings, in 1754, to the last great success in 1851. The time has arrived when the Council of the Society should make another great effort to complete the work it has so far successfully accomplished. Having brought public opinion to admit that civilisation and commerce were stimulated by the great International Exhibition of 1851, it must now endeavour to satisfy it that the advantages gained to Arts, Manufactures, and Commerce by one great gathering of the world's industry will soon be lost, and that England will fail to maintain the high position—morally and commercially—which she gained, as having been the first to inaugurate International Exhibitions, unless she now follows up that movement, and declares that International Exhibitions must be held periodically, and that the period between them must not exceed ten years. If they be held periodically most will admit that they should recur within the working life of each generation, and however liberal the average of years at which that life is calculated, it seems clear that an interval of ten years must absorb so large a portion of it, that while a majority might reasonably calculate on seeing two Exhibitions, very few men could hope to make profitable use of a third.

These Exhibitions should not be looked at in an exclusive spirit, but be valued as the best means under Providence so thoroughly to mingle the feelings and wants—the happiness and prosperity— of all nations, that public opinion, safely resting on the broad basis of common interests, should be able to exercise a continually-increasing control over the Governments of the world. Although no one who carefully watches events can doubt that this unseen moral power does beneficially influence the course of public events, yet it has still much to do in checking, by its influence, that wasteful expenditure of life and property in national arrangements, which abstract so much from the industrial power and wealth of the world—injuring Commerce, depressing Art, and retarding Manufactures.

In seeking, then, the support of the public for the first of a Decennial series of International Exhibitions to be held in 1861, the Council of the Society, judging by their published resolutions, are satisfied they are only helping to carry on what was seriously begun in 1851— not as a mere copy or repetition of that Exhibition, but as a Collection of Works of Art and Manufactures to show the world's progress since that time.

The Society does not propose to compete with 1851; the first International Exhibition ever held, and the first of a series to be held every ten years must obviously be quite distinct from the other.

It is proposed that the works to be exhibited in 1861 shall be selected for their excellence; that they shall be arranged in *classes*, and not according to *countries*; that Music and Painting shall be included; and that foreigners shall be admitted to contribute on the same conditions as British exhibitors.

The Advantages of Exhibitions.

All experience shows that periodical Exhibitions present a steady improvement in the quality and design of articles exhibited. The *public* are benefited educationally, socially, and morally, by such displays; and that *manufacturers* derive a direct profit from them is proved by the constantly increasing number of exhibitors. This is the case with all National Exhibitions in Belgium, Italy, Austria, Spain, Prussia, Sweden, Bavaria, and Russia, and particularly in France, where such exhibitions originated.

The first French National Exhibition was opened in Paris, in 1798, by the Marquis d'Avèze, the originator of the idea. It remained open three days, and the articles displayed were of an aristocratic and costly, rather than of a popular, character. The exhibitors numbered only 110 and a jury of nine men was appointed to decide upon their merits.*

The experiment was so successful as to lead to the adoption of periodical Exhibitions.

The second Exhibition took place in 1801, when the exhibitors were more than doubled: they reached 229.

The third Exhibition took place in 1802, after the very short period of one year. The exhibitors had increased to 540, and their productions showed an extraordinary progress in every department. Mechanical science had facilitated manufacture, and reduced the prices of all articles in popular demand.

The fourth Exhibition opened, after a longer interval, in 1806, supported by the largely increased number of 1,422 exhibitors.

The fifth Exhibition took place in 1819, after an interval of thirteen years, and comprised the moderately increased number of 1,662. It displayed a great improvement in many branches of popular manufacture.

The sixth Exhibition, in 1823, showed a slight decrease in the number of exhibitors, who, from 1,662, had fallen to 1,648. On the other hand, the jury rewards were increased from 809 to 1,091.

The seventh Exhibition, in 1827, had 1,795 exhibitors. Steam-power in manufacture began to be felt; goods had improved; prices had diminished; and the foundation was laid of a large export trade.

The eighth Exhibition was in 1834; a steady progress was shown in every industrial department, and the exhibitors had increased to 2,447.

The ninth Exhibition, in 1839, had 3,281 exhibitors, and was remarkable for its display of raw produce, and a purer taste of design.

The tenth Exhibition, in 1844, was supported by 3,960 exhibitors, of whom no less than 3,253 were honourably recognised by the jury.

The eleventh Exhibition, in 1849, comprised 4,494 exhibitors. Its great and predominating attraction was machinery.

English Exhibitions.

The above being the last Industrial Exhibition in France, previous to our Great Exhibition of 1851, we may now pass to the annual exhibitions of the Royal Agricultural Society of England, which show the same law of progress. They have held twenty exhibitions in different towns, from 1839 to 1858 inclusive. Starting from Oxford, twenty years ago, with nothing but a record of 350 head of cattle exhibited, they reached last year (1858), at Chester, a town contribution of £1,800, a list of receipts for admission amounting to £6,187, a list of exhibitors of agricultural implements reaching

* Report of M. Digby Wyatt, Esq., on the French Expositions. Sept. 1849.

197, another list of stock exhibitors reaching 402, with 1,444 head of cattle, and visitors amounting to 63,866.*

These shows of agricultural implements by the Royal Agricultural Society have led to such improvements in their design and manufacture as to have created a large and important export trade, prominently figuring in our export returns. The Council of the Royal Agricultural Society, on the motion of Mr. Brandreth Gibbs, the Hon. Superintendent of the arrangements for the Exhibitions, and therefore most intimately acquainted with the feelings of exhibitors, have decided on holding in 1861, if a site can be found, a Great Exhibition of Cattle and Implements in London, a proof that the Exhibition of Implements in Hyde Park, in 1851, was satisfactory to exhibitors and useful to agriculture.

In Horticultural Exhibitions a progress even more rapid has been shown. Not only have they led to improvements in the culture of native, and the naturalization of foreign plants, but they have taken botany out of its abstract existence in books and pictures, and have placed it practically before the eyes of the public, to aid in a useful, beautiful, and, what is gradually becoming a necessary part of education. The annual displays at Chiswick have been the creators of the Botanic Gardens, in the Regent's Park, as well as the displays of flowers which are among the most interesting and popular attractions of the Crystal Palace at Sydenham.

Their beneficial influence may be traced in many local displays and in many private plantations throughout the country.

The Exhibitions of Painting show a great amount of progress, as is evidenced by the National Gallery, the Royal Academy, and the Old and New Water Colour Societies.

Exhibitions of the Society of Arts.

Passing in review the history of Industrial Exhibitions in this country, the first that comes under notice is one held in 1829, under the patronage of King George IV., called "A National Repository for the Exhibition of specimens of new and improved Productions of the Artisans and Manufacturers of the United Kingdom," and which took place in the Royal Mews, Charing-cross. This, though under the management of a committee of distinguished men, with the Hon. G. Agar Ellis for its Chairman, was not sufficiently successful to warrant its being repeated. The idea of forming in England periodical exhibitions of the products of industry, in connection with the Society for the Encouragement of Arts and Manufactures, was conceived in 1845, when a committee of the Council of the Society of Arts was appointed to make the necessary inquiries as to the willingness of manufacturers to contribute their productions to such an Exhibition, and a fund was subscribed for the purpose of meeting the preliminary expenses, but owing to the want of sympathy on the part of the manufacturers the project was not then proceeded with.

*Date.	Place.	Town Contribution.	Amount paid for Admission.	No. of Implement Exhibitors.	No. of Stock Exhibitors.	No. of Head of Cattle Exhibited.
		£	£ s. d.			
1839	Oxford	...	...	...	...	350
1840	Cambridge	...	...	...	...	451
1841	Liverpool	...	...	...	...	463
1842	Bristol	...	...	84	...	497
1843	Derby	...	...	113	...	608
1844	Southampton ...	1000	2432 3 2	99	...	716
1845	Shrewsbury ...	1000	1682 19 5	93	...	527
1846	Newcastle	1000	2168 15 11	110	...	775
1847	Northampton ...	1200	2473 11 0	142	...	580
1848	York	1000	2514 12 0	146	...	866
1849	Norwich	1000	2360 15 10	145	...	799
1850	Exeter	1260	2493 19 4	118	...	769
1851	Windsor	600	3397 4 9	.. ‡	...	1226
1852	Lewes	1500	1184 10 4	105	247	828
1853	Gloucester	1500	2734 0 11	128	355	931
1854	Lincoln	1500	3378 6 5	130	331	939
1855	Carlisle	1400	3260 13 10	121	280	1076
1856	Chelmsford... ...	1200	2988 8 5	151	318	906
1857	Salisbury	1500	3447 15 9	156	356	1462
1858	Chester	1800	6187 5 5	197	402	1444

‡ Implements in 1851 were exhibited in London at the Crystal Palace.

The average number of visitors at the several country meetings, up to the Chelmsford meeting, was found to be about 35,000, but at Salisbury the actual number was 36,023, while at Chester it amounted to no less than 63,866.

The English people were then very imperfectly acquainted with the value of such Exhibitions and their influence upon the character as well as the commerce of the nation. They required to be educated for this object, and education had to be provided. Premiums for Works of Industrial Art and Exhibitions, on a comparatively small scale, were accordingly instituted by the Society of Arts for this purpose; and thus arose the Society's series of special premiums for specimens of British Arts and Manufactures, which, with the annual exhibitions of them, have formed so important an element in the progress of public knowledge and the formation of public taste.

So little advanced, however, was public information, that in 1846 hardly any competitors came forward, and it was with difficulty the judges could find subjects worthy of reward.

The first Exhibition of any magnitude—stimulated by His Royal Highness Prince Albert, the President of the Society of Arts—took place in the House of the Society in March, 1847. It would have been a total failure but for two individuals, who made it a point of personal favour, with a few great manufacturers, to be permitted to select from their stores a sufficient number of articles to make a show. The result was highly satisfactory. 20,000 people visited the Exhibition; and next year, in 1848, the exhibition on the part of manufacturers was spontaneous, and upwards of 70,000 persons visited the Society's rooms. The next Exhibition, in 1849, was still more successful; the visitors were more numerous, the articles sent in were of a superior quality, and the public taste was better educated to appreciate their excellence.

First International Exhibition.

It was obvious, during the progress of the foregoing Exhibitions, that the public mind was gradually becoming better informed on the nature and effects of great Public Exhibitions of Industry; and at the end of the Session, in June, 1849, everything seemed ripe for carrying into effect the plan of a Great Exhibition. On the 30th of June His Royal Highness stated the four great Divisions—of *Raw Material—Machinery and Mechanical Inventions—Manufactures—Sculpture, and Plastic Art*, of which he proposed the Exhibition should consist, and announced its distinguishing character of universality, as a collection of the Industry of all Nations.

At this period so little was known of the general feeling of manufacturers and agriculturists towards such displays in this country, that less than two years before the opening of the Great Exhibition, a commission was appointed to visit the principal towns in England, Ireland, and Scotland, and collect opinions from the leading men.* The result was most satisfactory. On the point of the *general expediency of such periodical exhibitions*, they met with the most perfect unanimity in all parts of the country, and expressions of surprise, if not regret, that our country should have been so tardy in instituting such an Exhibition. It was considered that the benefits of the Exhibition would be great, individually and nationally; that great good had been done on the continent by such exhibitions; and that the larger the competition the

* Report of Henry Cole and Francis Fuller, Esqrs., the Commissioners appointed. London, October, 1849.

better would it be for all. A willingness to exhibit was found to be very general; and, on the point of *whether prizes should be awarded*, although it was considered that the best prize was commercial success, it was admitted that the stimulus of worthy prizes would be beneficial, if a thoroughly impartial distribution could be secured.

On the important point of *whether such Exhibitions should be supported by a national grant, or by voluntary subscriptions*, the preponderance of opinions was *wholly* in favour of the voluntary principle, and it was generally considered that if the financial aid of goverment had been sought, the public would have felt themselves relieved, in a great measure, from the necessity of assisting.

Fifty towns were visited after this, and meetings were held, at all of which favourable resolutions were passed; and by January, 1850, the names of 60,000 influential persons had been obtained as supporters of the great plan.

About this date, on the application of the Society of Arts, the Royal Commission was appointed; the burden of the guarantee fund was thrown upon the voluntary contributors; and, in May, 1851, the building was successfully opened, under the energetic exertions and able organisation of the Executive Committee.

It remained open about five months and a-half; its foreign exhibitors numbered 6,556, and the exhibitors of the United Kingdom and dependencies 7,381, forming a grand total of 13,937. The estimated value of the articles exhibited (excluding the Koh-i-noor diamond) was:—

	£	s.	d.
United Kingdom	1,031,607	4	9
Dependencies of ditto.	79,901	15	0
Foreign countries	670,420	11	7
Total	£1,781,929	11	4

The number of prize medals awarded was 2,918, and of Council medals, 170. The daily admissions by payment reached 5,265,429, and the season tickets, 773,766; together, 6,039,195; the gross receipts were respectively £356,278 and £67,514; together, £423,792; and the nett profit was about £200,000, at present invested by Her Majesty's Commissioners, in land at South Kensington.*

Prospects of 1861.

Large as these results may appear, they show a comparatively small success if we look at the number of visits compared with the amount of local population.† The population of the metropolis in 1851 was 2,300,000, and this gives little more than two-and-a-half visits to each individual. The twelfth Exhibition at Paris, in 1855, shows an increase upon this, as, with a population of 1,200,000, the receipts reached £128,099, and the visitors 4,593,576, which gives three-and-three-quarters visits to each individual. The exhibitors, although showing a decrease upon those of 1851, in London, showed a marked increase upon those of the eleventh French Exposition, 1849. Their numbers were 9,790, without Algeria, as against 4,494; an increase greatly attributable to the admission, after our plan, of international exhibitors.

At the Dublin Exhibition, the daily admissions reached 634,523; the season ticket admission, 366,745; and the receipts respectively, £28,981 and £18,382. With the local population of 254,000, this gives nearly four visits to each individual.

At the Manchester Exhibition, the daily admissions reached 1,053,538; the season ticket admissions, 283,177; and the receipts respectively, £60,506 and £23,014. With the local population of 340,000, this gives nearly four visits to each individual.

Thus it will be seen that the visits, in proportion to population, at Manchester, Dublin, and Paris, considerably exceeded those of London in 1851. The two places where they showed a decrease were Cork and Birmingham.

At the Cork Exhibition, the daily admissions reached 74,095; the season ticket admissions, 54,936; and the receipts respectively, £2,874 and £1,545. With the local population of 86,000, this gives a little over one visit to each individual.

At the Birmingham Exhibition, held previously to the Exhibition of 1857, the visitors reached 80,882; and the receipts, £3,632. With a local population of 173,000, this gives rather less than one-half visit to each individual.

The New York Exhibition is left out of these calculations, as it was an entirely private enterprise, of the results of which the Society of Arts possesses no statistics.

If the numbers paying one shilling and under are separated from the higher rates, the following results appear:—In London, they were nearly two to one of the population; in Paris, just over three and a-half; in Dublin, just under two-and a-quarter; in Cork, about three-quarters; in Birmingham, just under a-half; and in Manchester, nearly two-and-three-quarters; all to one of population.

The lowest rate of admission in Paris was 4 sous, which produced £17,459 out of £128,000 sterling; at Dublin, sixpence, which produced £3,331 out of £29,000; at Cork, sixpence, which produced £1,200 out of £2,894; and at Birmingham, sixpence, which produced £691 out of £3,632. The one shilling admissions in London—the lowest rate—produced upwards of six-tenths of the whole receipts.

Leaving the facts of the past for the calculations of the future, we come upon the estimated increase of population in 1861.† This will be over half a million; or 2,885,800, as against 2,362,236 in 1851. This number is almost equally divided into males and females.

Next follows the change that will have taken place in the population during the space of ten years.‡ Taking the males at 1,442,900, one quarter of this number will consist, in 1861, of persons who were too young to benefit by the Exhibition of 1851, and one half will consist of persons between the ages of 15 and 50, capable of appreciating the New Exhibition. With regard to the female half of the population, their attendance as visitors is calculated to outnumber that of the males.

The number of visitors, however, must not altogether depend upon the population, but upon the facilities offered for conveying that population to the Exhibition.§

The following table, compiled from certain materials in Captain Galton's reports to the Board of Trade, will show that there has been a steady increase in railway traffic in England from 1849 to the present time.

	Separate Journeys in Round Numbs.	Increase.	Miles open.	Increase.	Journeys per mile.	Increase.
1849	64,000,000		5,579		11,442	
1850	73,000,000	9,000,000	6,326	747	11,515	73
1851	**85,000,000**	**12,000,000**	**6,755**	**429**	**12,640**	**1,125**
1852	89,000,000	4,000,000	7,113	358	12,531	*
1853	102,000,000	13,000,000	7,488	375	13,659	1,128
1854	111,000,000	9,000,000	7,846	358	14,160	501
1855	119,000,000	8,000,000	8,177	331	14,503	343
1856	129,000,000	10,000,000	8,502	325	15,213	710
1857	139,000,000	10,000,000	8,901	399	15,617	404
			ASSUMED.			
1858	148,500,000	9,500,000	9,251	350	16,017	400
1859	158,000,000	9,500,000	9,601	350	16,417	400
1860	167,500,000	9,500,000	9,951	350	16,817	400
1861	**177,000,000**	**9,500,000**	**10,300**	**350**	**17,217**	**400**

* Decrease 109.

* Report of Commissioners for the Exhibition of 1851.

† Letter of William Hawes, Esq., to the Chairman of the Council of the Society of Arts. London, Feb. 16th, 1859.—See *Journal*, vol. vii., p. 207.

† Letter of Registrar-General to the Chairman of the Council of the Society of Arts. London, Feb. 16th, 1859.—See *Journal*, vol. vii., p. 223.

‡ Letter of Charles M. Willich, Esq., to the Chairman of the Council of the Society of Arts. London, Feb. 18th, 1859.—See *Journal*, vol. vii., p. 223.

§ Letter of Colonel Owen to the Chairman of the Council of the Society of Arts. London, March, 1859.—See *Journal*, vol. vii., p. 243.

Had the increase of 9½ millions of railway journeys a-year been uniform, the number of journeys per mile in 1851 would have been only 12,132, giving an increase of 468. If this be multiplied by 6,755, the number of miles open that year, it will give us 3,161,340 journeys as the increase of travelling due to the Exhibition. Some of these additional journeys may have been due to other causes, but a large proportion of the travellers, on the other hand, must have paid more than one visit to the Exhibition, and there is, therefore, fair reason to assume that one and a half out of the six million visits to the building were from persons induced to come to London by the Exhibition; and the increase in the number of travellers was nearly four per cent.

Assuming the figures in the table to be tolerably correct, there will be 10,300 miles of railway open in 1861, with 17,000 travellers, in round numbers, to each mile. An increase of four per cent on this would be 680 per mile, instead of 468, or seven millions in 1861, against three millions in 1851.

It is, however, absurd to suppose that the country visitors to the Exhibition were only those who came to London on purpose. A large, and perhaps a larger proportion, must have consisted of persons who come daily to their business in London from the vicinity, or whom other pursuits may have called to London, and it is but a very moderate supposition that another 4 per cent. of the railway journeys of the year 1851 represented the ordinary travellers from the country who visited the Exhibition.

Thus there would be, supposing the attraction equal in 1861, 14 millions of railway journeys by visitors to the Exhibition against six millions in 1851, and, therefore, allowing two journeys, one up and one down, to each visitor, seven millions of country visitors instead of three millions, and the Exhibition of 1861 may afford to be less than half as attractive to command an equal numerical and pecuniary support from the country.

Assuming the remainder of the visitors of 1851 to be Londoners, and that they increased in 1861 in proportion to the increased population of London, there would be four millions instead of three for London, and seven millions instead of three for the country, which gives good ground for supposing that if the Exhibition of 1851 had taken place in 1861, it would have received eleven million visits instead of six millions.

These calculations apply exclusively to English railways.

The general system of railway management is much improved since 1851.* The continental managers have now learned to appreciate through booking, return tickets, and excursion traffic at reduced rates, which they would not look at a few years back. Many Continental lines have been opened since the year of the Great Exhibition, all more or less converging towards this country, and several others of great importance in shortening existing routes, and putting us in communication with new districts, will be completed during 1859 and 1860. The steam passages between America and Europe will be quadrupled in the present year (1859), and the fares lowered at least 30 per cent. The chain of railways now joining New York, Boston, Portland and Quebec, has been tripled since 1851; the distance between London and India has been decreased 25 per cent., and between England and Australia 50 per cent.; the time taken for passages to and from our West Indian colonies has been diminished one-third, and we have a well-organised steam communication with South America and Africa, which did not exist in 1851.

I have now gone briefly over the principal points in the past history of Industrial Exhibitions, and arranged a few carefully collected data as guides to the future.

I have shown that all such exhibitions are progressive; that nothing can blot them out; that they flourish under every form of government—a Directorate, a Consulate, an Empire, a Monarchy, or a Republic.

I have stated what was done in this country in the space of two years, before the organisation of such exhibitions had become, in some measure, a defined science, and I infer from this that the second exposition may be collected at a less proportionate cost than the first.

The Exhibition of 1851 was intended for a periodical Exhibition. The word "periodical" was used in every deputation to manufacturers or persons interested; and in almost every document issued by the Committees. The period fixed upon at that time (1849) by the Society of Arts was that of five years, and this was stated in the first application for a Royal Commission.

The proposition was based upon the fact that intervals of five years had been found sufficient in France between the different reviews of the country's industrial development. If any doubt could then have been entertained that these intervals were too short for England, the same objection cannot now apply to periods of double that length. The facts and calculations I have been enabled to gather of the great and general progress during the last ten years, are conclusive proofs that the decennial period is the extreme division to be accepted.

The Society was strongly of opinion that any beneficial results which the Exhibition of 1851 might accomplish could only be fully known when the condition of general industry should be again tested by a similar Exhibition; and that, if none such should be held, the good effects of the Exhibition of 1851 would subside and evil would ensue, the stamp of authority having been so fixed by the jurors of 1851 on many articles of production as even to create an obstacle to further improvements. Present experience has shown this to be the case. Many houses have made large fortunes upon the reputation deservedly obtained in 1851, though they may not be able to keep their ground at a future Exhibition. These firms will at first give a cold support to a project that presents a fair field for competition and distinction to every young and intelligent manufacturer; but when all the inevitable preliminary difficulties are cleared away, and the time comes for the preparation of goods for display, it will be a necessity of their commercial existence that they should no longer hold back.

The class of enterprising manufacturers and their power of production will be increased, thereby affording the prospect of a better display to the visitors; while the class of visitors and their power of consumption will also be increased, thereby affording the hope of a better reward to the manufacturer.

Periodical reviews of the state of Art, Manufactures, and Commerce are not only of advantage to the trading classes, as a great and profitable medium for advertisement, but are a means of preventing that decay of certain branches of industry—(as the china trade of Derby, and the carpet trade of Axminster)—which is, to some extent, a national disgrace. Upon the educational effects of all such exhibitions we need hardly dwell. The improvements in decorative art and in popular illustrated literature, since 1851, are proofs of a general advance in taste, that may be attributed, in some degree, to the influence of the last great display. Such exhibitions, by creating a demand for excellence, rather than for quantity, also improve the position of the skilled workman, and increase his reward at the same time that they teach him to regard his labour as an art.

Of the details of the proposed Exhibition it is of course premature, at present, to speak. Much will depend upon the selection of the site, and no spot, having due regard to the means of cheap and easy access, with railways about to come almost to the very spot, seems more eligible for the purpose than the large number of acres of dry, gravelly soil that is held by the Commissioners of 1851 at South Kensington. It possesses the advantages of being ready for instant occupation; in the hands of

* Letter of Sir Cusack P. Roney to the Chairman of the Council of the Society of Arts. London: Feb. 16, 1859. See *Journal*, vol. vii., p. 191.

trustees who derived it from the proceeds of the former Exhibition, and of being in a tolerably central position, if London is taken in connection with its outlying districts. It is on the border of a main line of road, leading from east to west, which is well supplied with cheap numerous conveyances. It is also favourably situated for that large class of visitors, who will be compelled to walk, and whose requirements must be specially looked to in all undertakings of this kind that wish for anything like success. The place has other features to recommend it. The Museum of Science and Art is already established there, and if the Horticultural Society of London should succeed, as they desire, in carrying their annual botanical displays to this ground, there will then be a centralisation of Exhibitions such as it is most desirable for the country to see.

To give proper confidence to guarantors and exhibitors, the undertaking should have a national character, and be carried on under the countenance, if not under the immediate direction of a properly constituted authority.

The Council of the Society of Arts have received numerous offers of support, upon a much more popular and extended basis than on the last occasion, sufficient to enable them to undertake with confidence the task of finding four-fifths of what they consider the necessary guarantee. If her Majesty's Commissioners of 1851 will sign for £50,000 out of £250,000, and allow it to be announced that, provided this guarantee is completed by a given day, they will hold the Exhibition of 1861 on their own ground at South Kensington, the Council of the Society of Arts should be prepared to take upon itself the labour and responsibility of completing the necessary sum.

With railway facilities increased fifty per cent., with a population not only much changed and much advanced, but increased twenty per cent., and with the consequent increase of capital to that extent, there cannot be any doubt that, with a little timely energy and co-operation, the proposed Exhibition of 1861 will become a great and splendid success.

EXHIBITION OF INVENTIONS.

The Society's Eleventh Annual Exhibition of recent Inventions will be opened on Monday the 25th inst.

Persons intending to be Exhibitors should communicate with the Secretary of the Society of Arts as soon as possible, stating :—

1st. The Title of the Invention.

2nd. Whether the Article will be a Model, Drawing, or Specimen.

The Articles must be forwarded to the Society's house, carriage paid. The days fixed for receiving them are Thursday the 7th, Friday the 8th, and Saturday the 9th inst. No articles will be received after the last of these days.

Articles which have been included in previous Exhibitions of the Society of Arts cannot be re-admitted.

Articles should be accompanied by a short but clear description of the Invention, with a wood block (when possible) for illustration, and a reference to any publication in which the Invention is described.

All Drawings exhibited must be framed.

No charge is made for space, and the admission to the Exhibition is free.

CONVERSAZIONI.

The Council have arranged for two Conversazioni during the present Session; the first, on Saturday, the 7th May, at the Society's House, the card for which will admit the Member only; the second, on Saturday, the 28th May, at the South Kensington Museum, the card for which will admit the Member and two ladies, or one gentleman.

EXAMINATION PRIZE FUND FOR 1859.

The following are the Donations up to the present date :—

	£	s.
John Ball, Examiner in Book-keeping (2nd donation)	5	5
Harry Chester, Vice-Pres. (2nd donation)...	5	0
C. Wentworth Dilke, Vice-Pres., Chairman of Council (4th donation)	10	10
T. Dixon	1	1
Frederick Edwards (annual)	1	1
J. G. Frith, Mem. of Council (2nd donation)	5	5
F. Seymour Haden (annual)	2	2
— Haldimand	10	10
Edward Highton (annual)	2	2
James Holmes (annual)	1	1
Henry Johnson (2nd donation)	25	0
London Committee of the Oxford Middle Class Examinations	5	5
Charles Ratcliff (annual)	10	10
Rev. Dr. Temple	6	6
Matthew Uzielli	50	0
Rev. A. Wilson	2	2

EXAMINATIONS, 1859.—LOCAL BOARDS.

The following Local Boards have been appointed since the last announcement :—

For Ashbourn Literary Institute.

Mr. J. Bamford, Solicitor.
Mr. J. Bowman, B.A., Grammar Schoolmaster.
Mr. T. Coleman, Solicitor.
Rev. W. A. Duckworth.
Mr. Green, Certificated Schoolmaster.
Captain Holland.
Mr. Marshall, Certificated Schoolmaster.
Mr. J. Walker, Grammar School, *Secretary*.

For Paisley.

Mr. Wm. Brunton, LL.D.
Mr. Thomas Coats, Ferguslie.
Rev. William Frazer.
Mr. Thomas Glen, Hillhead.
Mr. Peter Kerr, Whitehaugh.
Mr. Jas. J. Lamb.
Mr. Wm. Mackean.
Mr. D. Murray.
Mr. A. R. Pollock, Greenhill.
Mr. Louis Pujet.
Mr. James Reid.
Herr Rheban.
Mr. J. Smart.
Rev. Andrew Wilson.
Mr. Robert Wilson.
Thomas Macrobert, } *Secretaries.*
M. B. M'Kinlay, M.D. }

NOTICE TO LOCAL BOARDS.

Forms No. 1 and No. 2 (see Appendix to the Examination Programme) have been issued to the Secretary of each Local Board, and careful attention to them is particularly requested.

SEVENTEENTH ORDINARY MEETING.

Wednesday, March 30, 1859.

The Seventeenth Ordinary Meeting of the One Hundred and Fifth Session was held on Wednesday, the 30th inst., W. Fothergill Cooke, Esq., in the chair.

The following candidates were balloted for and duly elected members of the Society :—

Canterbury, the Very Rev. the Dean of | Keysell, Richard | Pollard, George
Vallance, Henry

The following Institutions have been taken into Union since the last announcement :—

Lincoln, Newland Young Men's Mutual Improvement Society.
London, Young Men's Christian Association, Aldersgate-street.

The Paper read was—

ON THE PRACTICAL BEARING OF THE THEORY OF ELECTRICITY IN SUBMARINE TELEGRAPHY, THE ELECTRICAL DIFFICULTIES IN LONG CIRCUITS, AND THE CONDITIONS REQUISITE IN A CABLE TO INSURE RAPID AND CERTAIN COMMUNICATION.

By S. Alfred Varley, Assoc. Inst. C.E.

Since the practical realization of the electric telegraph, several valuable communications connected with the subject have from time to time been laid before this Society.

These papers have generally treated of the mechanical details and improvements in the apparatus which have been designed and brought forward by various patentees and inventors.

In the course of the discussions which have taken place it has appeared to me that the principles of the science of electricity have not always been sufficiently appreciated, and the practical value of many of the beautiful contrivances not elicited, from not having determined clearly the principles of the science which are involved in telegraphing, and, consequently, the properties which are essential, and must be possessed by all apparatus, to give them a practical value.

This feeling has led me to think that a paper on the Theory of Electricity, keeping always in view its bearing on electric telegraphy, and which should rather treat of the principles of telegraphic apparatus than confine itself to special contrivances, would be subservient to the progress of the object we have in view; for it must not be forgotten that although the world is always indebted to the practical man for the application of science to commercial purposes, and, in the case of the electric telegraph, it is even questionable whether we are not indebted for its very rapid extension in part to the inability of the projectors to appreciate difficulties which the philosopher foreseeing would have hesitated at—or, perhaps, to the greater faith possessed by the practical man in the ability of science to overcome whatever difficulties may present themselves; yet it must not be forgotten that, in the principles of a science, the philosopher is often far ahead of the practical man, and the latter at times comes suddenly and unprepared upon difficulties, which, had he understood correctly the principles long before developed by science, he would have been led to expect as natural consequences. As an example of this, I would mention the case of electric induction, which manifested itself so strikingly when the system of subterranean circuits was considerably extended on the introduction and successful manipulation of gutta percha.

This phenomenon was unexpected and unlooked for by many, though not all, of our practical electricians; and we find it referred to, and regarded at the present time, as a new fact which the electric telegraph has brought to light, and not one to have been anticipated; yet the laws of induction were beautifully and clearly developed by Dr. Faraday, as far back as 1838; and, when called upon to examine this new telegraphic difficulty, we find him alluding to it in an instructive lecture, delivered before the members of the Royal Institution, as a strong confirmation of the truthfulness of views he had put forth as far back as 1838. I would direct attention particularly to this, because I cannot help feeling that our progress is too often obtained by a laborious perseverance in almost empyrical experiments, until, by the laws of chance, a successful result is hit upon, instead of endeavouring, in the first place, to develop a guiding principle, and referring back to it, as each step forward is made, to test both the truth of the principles laid down and the correctness of the conclusions arrived at. Were this done, experience would not be paid for so dearly; and the commercial application of a science would not be almost paralyzed, as it sometimes is on its first introduction, by the costly series of experiments which have to be gone through before correct principles of working are established.

During March, 1858, the subject of telegraphic cables was very fully entered into by the Institution of Civil Engineers. Finding at that time that there were no papers on the electrical portion before the Institution, and feeling that the subject could not be fully considered without the electrical part being entertained, I was induced at the eleventh hour to attempt to supply the deficiency. Some explanation is perhaps therefore due from me for bringing forward, so shortly afterwards, another paper on almost the same subject. Owing to the large number of evenings which had already been occupied in the consideration of the mechanical portion of the problem, and the late hour at which my paper was submitted, it was only read in abstract, and no discussion taken upon it. The views, too, I then brought forward were opposed to some which have lately been laid very prominently before the public, and no opportunity given to contradict them, or to verify their correctness; and as I am convinced that so far from the subject being exhausted its importance is only now beginning to be appreciated, the opportunity having been offered to me to bring the matter before the Society of Arts I determined to avail myself of it.

The complete way in which the subject was taken up by the Institution of Civil Engineers is, however, I am glad to say, already bearing fruit; and since the publication of the papers by the Institution, several valuable discussions have taken place in the scientific journals, and in some of the remarks I have to lay before you to-night, I find, to a certain extent, I have been anticipated.

The generally recognised theory of electricity, as I understand it, supposes all bodies in their normal condition to have two powers or forces resident in them directly opposite in their character, being exactly balanced; in bodies in their natural state these forces are completely neutralized and rendered inactive, producing the ordinary condition of matter.

To these powers the name of electricities has been given, and although we are still as ignorant at the present day as the ancients themselves with regard to what electricity actually is, yet the fact of the existence of

the electric telegraph is a proof of the progress which has been made in a knowledge of the laws, at least, which govern electric phenomena.

In the year 1838, Dr. Faraday clearly developed the principles of induction and conduction, since which time no further progress has been made in the fundamental truths of the science, though much has been done to confirm their correctness and to develop their consequences.

In the Philosophical Transactions for 1838, will be found Dr. Faraday's views on the subject of induction and conduction; and these, to my mind, so clearly explain all electric phenomena, that it will be as well at once to refer to them before proceeding further. After giving reasons for his belief in the identity of induction and conduction, he says, "all these considerations impress my mind strongly with the conviction that insulation and ordinary conduction cannot be properly separated when we are examining into their nature, that is, into the general law or laws under which their phenomena are produced. They appear to me to consist in an action of contiguous particles dependent on the forces developed in electrical excitement; these forces bring the particles into a state of tension or polarity, which constitutes both induction and insulation, and, being in this state, the continuous particles have a power or capability of communicating their forces one to the other, by which they are lowered, and discharge occurs. Every body appears to discharge, but the possession of this capability in a greater or smaller degree in different bodies, makes them better or worse conductors, worse or better insulators, and both induction and conduction appear to be the same in their principle and action, except that in the latter an effect common to both is raised to the highest degree; whereas in the former it occurs in the best cases in only an almost insensible quantity.

In part the 2nd of the Philosophical Transactions of the same date will be found a summary of Dr. Faraday's views, which I will also quote :—

"1st. The theory assumes that all the particles, whether of insulating or conducting matter, are, as wholes, conductors.

"2nd. That, not being polar in their normal state, they can become so by the influence of neighbouring charged particles, the polar state being developed at the instant, exactly as in an insulated conducting mass consisting of many particles.

"3rd. That the particles when polarised are in a forced state, and tend to return to their normal or natural condition.

"4th. That being, as wholes, conductors they can readily be charged either bodily or polarly.

"5th. That particles which, being contiguous, are in the line of inductive action, can communicate or transfer their polar forces one to another more or less readily.

"6th. That those doing so less readily require the polar forces to be raised to a higher degree before this transference or communication takes place.

"7th. That the ready communication of forces between contiguous particles constitutes conduction, and the difficult communication insulation; conductors and insulators being bodies whose particles naturally possess the property of communicating their forces easily, or with difficulty, and bodies having these differences as they have differences of any other natural property.

"8th. That ordinary induction is the effect resulting from the action of matter charged with excited or free electricity upon insulating matter, tending to produce in it an equal amount of the contrary state.

"9th. That it can do this only by polarising the particles contiguous to it, which perform the same office to the next, and these again to those beyond; and that thus the action is propagated from the excited body to the next conducting mass, and these render the contrary force evident in consequence of the effect of communication which supervenes in the conducting mass upon the polarisation of the particles of that body.

"10th. That, therefore, induction can only take place through insulators; that induction is insulation, it being the necessary state of the particles, and the mode in which the influence of electrical forces is transferred or transmitted across such insulating media."

To determine for myself the law which induction obeys, in conjunction with my brother, Mr. C. John Varley, I have tried some experiments.

The principle upon which these were based was that of the dual character of electricity, and the fact established by Dr. Faraday, that all statical charge is sustained solely and entirely by induction.

In bodies in their normal condition, the opposite forces or electricities being balanced and united, no attraction for neighbouring particles exists, but when these forces are separated, as in the case of a Leyden jar, the attraction which a given quantity of electricity exerts for the similar amount of negative on the opposite coating, will be less in proportion to some law as the thickness of the dielectric intervening is increased.

It was therefore assumed that the amount of free attraction under these circumstances, or more correctly the amount of induction which would be thrown upon neighbouring bodies, would increase inversely as the attraction between the opposite coatings diminished.

The apparatus made use of was constituted in the following way :—

A glass pillar, varnished, for better insulation, was mounted upon a board. On the top of this a brass plate was attached, and upon this plate the dielectric to be examined was laid. Over the dielectric another brass plate was then placed.

A Leyden arrangement was thus constructed, the upper and lower brass plates representing the inner and outer coatings of an ordinary Leyden jar.

A brass ball, suspended from a balance which had an adjusting arrangement, so that it could be raised or lowered, hung over the upper metal plate at a short distance from it.

The *modus operandi* was as follows :—

The upper brass plate was connected to the earth, and a series of sparks, through the medium of a sliding rod kept at a fixed distance from the prime conductors of a frictional machine, thrown into the lower brass plate of the Leyden arrangements, or the prime conductor was kept fully charged, and a carrier ball attached to a long glass rod was made use of to measure out definite quantities of electricity.

The room in which the experiments were performed, was heated with a stove, and the dryness of the atmosphere indicated by a hygrometer, so that the insulation might be as perfect as possible.

When a certain number of sparks had been thrown into the lower brass plate, the upper brass plate was disconnected from the earth, and the lower one attached to the balance, and if the tension of the charge was sufficient, the brass ball suspended from the balance was attracted down, and discharge ensued. The experiment was repeated again and again, and the number of sparks requisite to just attract the ball down, noted.

Glass plates were the dielectric employed, and the experiment was tried first with one plate, then with two, and then with three plates of glass between the upper and lower brass plates, the brass ball suspended from the balance being kept always at a certain fixed distance from the upper brass plate.

The results obtained from a numerous series of experiments were—that when two plates of glass were placed between the brass plates, only half the number of sparks which were required to raise the tension of charge sufficiently to cause discharge when one plate of glass separated the brass plates was requisite, and when three plates of glass divided the upper and lower brass plates, then a third of the number of sparks raised the charge to

the same degree of tension, showing that through flat plates of glass, induction decreases in the inverse proportion to the thickness of the dielectric, that is to say, if the induction through one be 12, through 2 it will be 6, through 3—4, and so on.

In the case of a gutta percha covered wire, it was anticipated that as when the thickness of the gutta percha is increased, the outer surface increases at the same time, the decrease of induction consequent on the increased thickness of the insulating material would not be inversely proportionate to the depths of the gutta percha, but would follow some other law.

To put this to the test, a series of Leyden arrangements were constructed in the following way: three pieces of tube, of half an inch internal diameter, and 2 feet 6 inches long, were placed in the centre of tubes of 2 feet long, the internal diameters of which were 1 inch, $1\frac{1}{2}$ inches, and 2 inches, and the space between the inner and outer tubes filled with melted resin. (Figs. 1, 2, 3.)

Fig. 1.

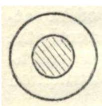


Fig. 2.

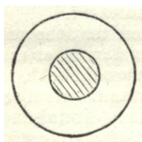
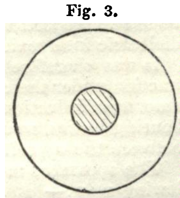


Fig. 3.



By this means three Leyden arrangements, with a uniform internal surface, but whose insulating material varied in thickness in the proportion of 1, 2, and 3 were constructed, and the same process as that already described with the flat plates was repeated.

The results obtained are shown in the annexed table.

Diameter of Inner Tube.	Thickness of Insulation.	Diameter of Outer Tube.	Inductive Force.
10	5	20	22
10	10	30	15·5
10	15	40	11·5

These results were very constant, but as resin was the only dielectric employed, the experiment requires repeating with other dielectrics, for there is reason to believe that with glass at least the decrease in induction consequent on an increased thickness of the dielectric would be somewhat greater than that indicated in the above table.

The reasons for this belief are the following:—When a galvanic battery is connected with the inner and outer coatings of a Leyden arrangement, induction will take place through the dielectric, and if the surfaces of the two coatings are equal, then the force will be equally divided over them; that is to say, if the battery force be 100, the tension of the charge on the one coating will be 50, and that on the other will be 50 also=100.

Let the surface of the outer coating be supposed to be infinite in extent, then the tension of the charge on the inner coating will approach infinitely near to 100, and the tension of the charge on the outer coating will be almost nil. An example of this we have when the earth represents one of the coatings of a Leyden arrangement; and this is the case in the prime conductor of a frictional machine, and also in the suspended wire of a telegraphic circuit; in these two examples the prime conductor of the machine and the wire of the telegraphic circuit represent the one coating, the air the dielectric, and the earth the other coating.

Now consider a case where the outer surface is double that of the inner one, the tension of the charge on the inner coating will then be double that of the *outer*; an example of this we have in the above table, where the inner surface is 10, the thickness of the insulation 5, which may here be regarded as unity, and the outer surface 20—the battery force being 100. Divide this into three parts, and we get $33\frac{1}{3}$. Give two parts for the tension of the charge on the inner coating, and one part for the tension of the charge on the outer coating, then we shall have for the tension of the inner surface, $66\frac{2}{3}$; for the outer surface, $33\frac{1}{3}$=100 when united.

Now, consider the third example in the above table. Inner surface 10, thickness of insulation 15, outer surface 40, or quadruple that of the inner surface. In this case the tension of charge on the inner surface will be four times that of the charge on the outer surface. In other words, the tension of the charge on the smaller surface will be 80, and that of the outer surface 20, the united tensions equalling 100; but the thickness of the insulation is 15, or three times that of the first example; and it has been shown that induction decreases in the inverse proportion to the thickness of the insulating material; we shall therefore have to divide by 3, and and this will give 26·6 for the tension of the charge on the inner surface.

In the first example it has been shown that if the force be 100, the tension of the charge on the inner surface will be $66\frac{2}{3}$, which, to avoid fractions, we may regard as 67. In the actual experiment the inductive force measured was 22; 67, therefore, represents 22, and as 67 is to 22 so should 26·6 be to the amount of force which would be expected to be obtained in the last example; this, when calculated by a simple Rule of Three sum, gives 8·8 for the amount of inductive force. In the actual experiment the force obtained was 11·5, a result, therefore, sufficiently near to warrant further investigation, to ascertain whether the law which would seem to be indicated is correct, and whether it holds good with any other dielectric, such as glass, in which case the cause of the discrepancy, when resin is the dielectric employed, should be sought after.

I now proceed to conduction.

The law which governs the conduction of electricity has been very accurately ascertained, and would seem to follow the same law as induction, that is to say, if the sectional area be uniform throughout, the resistance which a conductor will oppose to the passage of a current will be directly relative to its length; or, the length of the conductor being determined, the resistance will be relative to its sectional area. In other words, a wire one mile long will oppose half the resistance of that which will be opposed by a similar wire two miles long; and two wires, each two miles long, placed side by side, which is the same thing as one of twice the sectional area, will oppose exactly the same resistance as a single wire one mile long.

The next thing to be considered is the part which the quantity and intensity of electric currents play in electric phenomena.

The amount of force developed by an electric current, whether it be the deflection of a needle, the attraction of an armature in an electro-magnet, or the decomposition of water, is always relative to the dynamic quantity flowing.

This fact has been well established, and the difference between quantity and intensity accurately defined; yet still, in practice, there is a want of a clear comprehension of the relationship of those terms.

Let a battery—say of ten pairs of elements, with ten inches of surface in each cell—be joined through a circuit perfectly insulated, and opposing very great resistance to the passage of the current; and the amount of force, or in other words, the dynamic quantity of electricity flowing, be weighed off by a magnetometer, and noted down. If now this battery be disconnected, and another of the same number of elements, but with twice the surface, be connected in its place, practically no more will be found to be flowing through the circuit than in the former case, the resistance which the wire opposes measuring out the quantity passing somewhat in the same way as the height of the column, and not the

quantity of water, in a cistern, regulates the rate at which it flows from an orifice inserted in it.

Let the series be increased, and more will be urged through; and, if the number of cells be sufficiently numerous for practical purposes, the same dynamic quantity as a single cell would generate through a circuit of no resistance, will be found to be flowing.

In theory this point can only be approached, for the resistance of the wire can never be completely overcome. In theory, also, when the number of elements is not increased, the larger the surface the greater will be the dynamic quantity flowing, for the tension of the current is lowered in proportion to the amount of electricity flowing out of the battery; and, when drawing from a larger reservoir, which batteries of greater surface may be compared to, this same amount will not lower so much the general tension; consequently, there will be more intensity to urge the current through. But to return to practice. If the number of cells has been sufficiently extended so as to generate the same dynamic quantity as a single cell does through a circuit of nominally no resistance, a further addition to the series will not be attended with any beneficial effect, for there is already power enough to urge through all the electricity the battery is capable of generating; and the force developed is directly relative to the dynamic quantity flowing. Tension is only the medium by means of which this dynamic quantity is forced through the circuit.

It will be as well, perhaps, to define more precisely what is wished to be understood by the term resistance. When it is said that one circuit opposes twice the resistance of another, it is meant that the same tension of current will force half the dynamic quantity only through this circuit that it would through one opposing half the resistance; it follows that a given length of wire opposes the same resistance to half the dynamic quantity of electricity that half this length of wire does to double the dynamic quantity, and hence all circuits oppose to an infinitely small quantity of electricity an infinitely small amount of resistance.

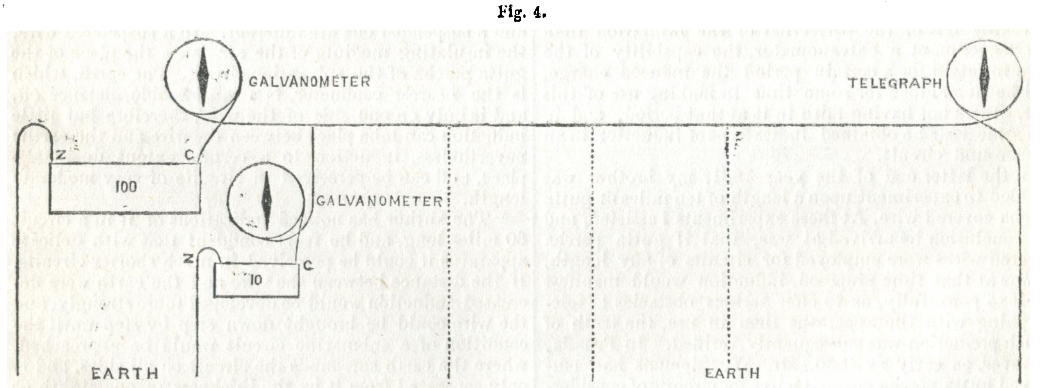
The way in which quantity and intensity affect practical telegraphing has next to be considered, and whether there be any advantage in employing comparatively large over smaller dynamic quantities of electricity.

It may be generally stated that when the insulation is very perfect there is no great difficulty in working with minimum quantities; but when the insulation is imperfect, larger dynamic quantities hold out a better prospect of working through.

When a current is flowing through a circuit which offers, practically speaking, no resistance, let the cells of the battery be ever so numerous, it will possess no intensity worth noticing, for, as there is no resistance opposed to the force resident in the battery, the intensity is not brought into play. It is something like a powerful engine raising a light weight, the force is latent, but not brought into action.

Let the battery, however, be connected through a circuit opposing considerable resistance; its intensity will then be developed.

Fig. 4.



Let the diagram (Fig. 4) represent a circuit which fulfils these conditions, one end of the wire dipping into the earth in the usual way, and the other connected with the copper pole of a battery composed of a numerous series of elements possessing very little surface and, consequently, capable of generating only a small dynamic quantity of electricity, and let the circuit be completed by connecting the zinc pole to the earth.

The current will flow from the copper pole through the wire, thence to the earth, and back to the battery, and its working intensity will be dependent on the resistance which the circuit opposes, and can be measured in the following manner:—

Let another battery, but with a much smaller number of elements, be connected side by side with the larger battery to this wire, the zinc pole being connected to the earth and the copper to the wire, and introduce galvanometers in the circuit, between the large battery and the wire and between the small battery and the wire, so as to indicate the direction in which the currents are flowing.

Both batteries will desire to send a current through the circuit in the same way, but should the small battery oppose much less resistance to the passage of a current through itself than is opposed by the long wire, then the greater quantity of electricity generated by the large battery will pass that way in preference to through the wire, and paralyze the action of the smaller battery; but if cell after cell be added to this little battery, when its intensity becomes greater than the resistance of the wire, a current will flow from it also in the same direction as that from the large battery through the wire, and the number of cells requisite just to do this will be an exact measure of the working intensity of the current.

Let the case now be considered where the insulation is not perfect; if there be sufficient leakage to let the small dynamic quantity, which the battery can only generate, escape on the road, no appreciable amount will reach the further end, the tension of the current will be lowered, and a less number of cells in the little battery will now be found to balance it.

Adding to the number of these small pairs of elements will not give any appreciable assistance, but let the surface in each of the cells of the larger battery be increased so that a greater quantity may be generated than can escape through the leaks, represented in the diagram by the dotted lines, an appreciable amount will then reach the further extremity, and the telegraph instrument be rendered active. In such a case as this, adding quantity will raise the working intensity of the current, whilst increasing the intensity of the battery alone will scarcely affect it.

In some experiments tried by my brother, Mr. Cromwell Varley, and myself, on long leaky circuits, increasing the surface of the batteries alone, without adding to the series, raised the deflection on the galvanometer from 22° to 53°; and the last intelligible words uttered by the Atlantic cable, "Daniells are now in circuit," is a further testimony of the correctness of what has just been advanced.

The correctness of considering the inductive phenomena which manifest themselves in subterranean and submarine circuits, as a new fact suddenly brought to light, has been called in question in the early portion of this paper; a few words on its history will therefore not be out of place, before considering the way in which it affects telegraphing.

In 1838, Dr. Faraday pointed out the conditions which would cause the retardation of an electric impulse in its passage through a conductor.

In 1848, the electric telegraph was in actual operation. The method adopted at that time for the insulation of the wires passing through towns, was to enclose a number of cotton covered wires in a leaden tube, and then fill the tube with a mixture of resin and Stockholm tar.

Reasoning on Dr. Faraday's observations, my brother, Cromwell Varley, was led to think that such circuits possessed conditions favourable for induction to manifest itself; he therefore searched for it, and succeeded in obtaining indications of induction.

In 1849, gutta percha had been introduced, and as the insulation in gutta percha covered wires was much more perfect than in the cotton covered ones enclosed in leaden pipes, induction manifested itself much more strikingly, and my brother made use of from that time as a more searching test of the perfection of the insulation than the deflection of a galvanometer, the capability of the wire to retain for a certain period the induced charge, and he stood alone for some time in making use of this test, others not having faith in it at that period, and in the same year he obtained indications of induction in an overground circuit.

In the latter end of the year 1851, my brother was enabled to experiment upon a length of ten miles of gutta percha covered wire. At these experiments I assisted, and the conclusion he arrived at was, that if gutta percha covered wires were employed for circuits of any length, as was at that time proposed, induction would manifest itself so powerfully, as to offer serious obstacles to telegraphing with the apparatus then in use, the truth of which prediction was subsequently verified. In Prussia, however, as early as 1850, Mr. W. Siemens had employed gutta percha covered wires for circuits of considerable lengths, and encountered the inductive phenomena, an account and explanation of which he published during that year.

This fact was not known on this side of the channel until after gutta percha covered wires throughout the whole lengths of the circuit were also employed in this country, and that was in the year 1854.

To Dr. Faraday, however, is due the whole credit in this matter, and I have only alluded to its telegraphic history, as I cannot help feeling it as a sort of reproach to practical electricians that it should go forth that induction, which was manifesting itself step by step before their eyes, came suddenly and unexpectedly upon them. The following extract from Dr. Faraday's researches of 1838 is so instructive, and teaches such a valuable lesson, that I cannot refrain from quoting it. Alluding to Professor Wheatstone's well-known experiment, he says,—"If the two ends of the wire were immediately connected with two large insulated metallic surfaces exposed to the air, so that the primary act of induction, after making contact for discharge, might be in part removed from the internal portion of the wire at the first instant, and disposed for the moment on its surface, jointly with the air and surrounding conductors; then, I venture to anticipate, the middle spark would be more retarded than before, and if these two plates were the inner and outer coatings of a large jar, or Leyden battery, then the retardations of that spark would be still greater."

Previous to the first attempt to submerge the Atlantic cable, a series of experiments were undertaken by the company's late electrician, and the result published.*

These experiments having been tried, at the expense of much capital, and with opportunities which never before presented themselves, are two important not to be noticed, though it is believed that the author of them has lately had reasons to modify some of his conclusions.

The chief results published were these:—

1. That no adequate result is obtained by increasing the sectional area of the conductor; that, in fact, in the case of a submarine circuit—a small wire will transmit signals more rapidly than a larger one.

2. That an insulated submarine wire conducts according to a different law to that of a suspended circuit.

3. That the rate at which a voltaic signal travels is not affected by the intensity of the battery.

4. That magneto-electric induced currents have the property of travelling in the first place faster than voltaic ones; and, unlike voltaic currents, when their intensity is increased their rapidity of travelling is increased also.

In the paper I submitted last March to the Institution of Civil Engineers, I pointed out what I conceive to be errors in these results, and endeavoured to show that some of them necessarily followed from the way in which the experiments were conducted, and I cannot more clearly express what I wish to convey on this head than by quoting my own remarks on that occasion.

"In examining these conclusions, it has first to be considered whether the conditions of a submarine circuit and a suspended one are different. In a suspended wire, the insulating medium of the air takes the place of the gutta percha of the submarine circuit. The earth, which is the nearest conductor, is a considerable distance off, and is only on one side of the wire, therefore but little induction can take place between the wire and the earth; nevertheless, induction to a certain extent does take place, and can be perceived in circuits of very moderate length.

"The author has noticed indications of it in a circuit 60 miles long, and he feels confident that with delicate apparatus it could be perceived in much shorter circuits. If the distance between the wire and the earth were decreased, induction would be developed more strongly, and the wire could be brought down step by step until the condition of a submarine circuit would be approached, where the earth surrounds the circuit on all sides, and is only separated from it by the thickness of one-eighth or three-sixteenths of an inch of gutta percha—a substance possessing, moreover, specifically a much greater inductive capacity than air. It, therefore, appears, that the conditions are precisely the same, only differing in degree. Before proceeding further, and to prevent the possibility of mistake, it is desirable to make the following quotation from the work previously referred to:—†

"'The law of squares may possibly apply to the transmission of electricity freely along simple conducting wires, but it certainly does not apply to the case of its transmission along submarine and subterranean gutta percha covered wires (the facility of transmission being estimated by rate of speed) because in this the case is not one of simple conduction, but of transmission, after the wire has been charged inductively to saturation as a Leyden jar.' This quotation shows clearly the reason for concluding that small wires are better conductors for submarine circuits, as far as transmission is concerned, than larger ones; for the smaller the Leyden jar the more quickly will it be charged to saturation. The author, in differing from these conclusions, does not wish it to be

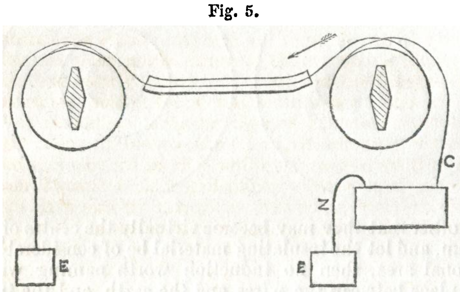
* *Vide*, "The Atlantic Telegraph. A History of Preliminary Experimental Proceedings, &c., published by order of the Directors of the Company."

† *Vide*, "The Atlantic Telegraph," page 23.

understood that he thinks the law of squares is applicable to submarine wires; for he is not aware of any electrical phenomena which obey that law, but he submits that there is a material difference between a Leyden jar and a submarine wire.

"In a Leyden jar the inner and outer coatings are perfectly insulated one from the other. If they were not insulated there could be no statical charge, as is well understood by all electricians. Induction therefore *involves insulation*. But in a submarine circuit this is not the case. If the wire at the further extremity was disconnected from the telegraph instrument, and sealed up with gutta percha, the conditions would be nearly the same. In practice, however, it is quite open through the instrument to the earth, and the resistance opposed by the very long length of wire is the only insulation between the inner and outer coatings, for it unites both, being in connection with the earth at both ends (Fig. 5).

Fig. 5.



It is therefore evident that if the wire offers no resistance there will no insulation, and, as a consequence, no induction to retard the passage of the current. It is also equally plain that precisely in proportion to the resistance which the wire opposes, provided always the insulating medium be of the same thickness, will induction manifest itself and retardation be experienced.

"There is also another difference between a Leyden jar and a submarine circuit.

"The Leyden jar is charged uniformly all over, whilst in a submarine wire the tension of the charge varies in different portions of the circuit, being at its maximum at the end where contact is made with the battery, and dying off to nothing at the further extremity."

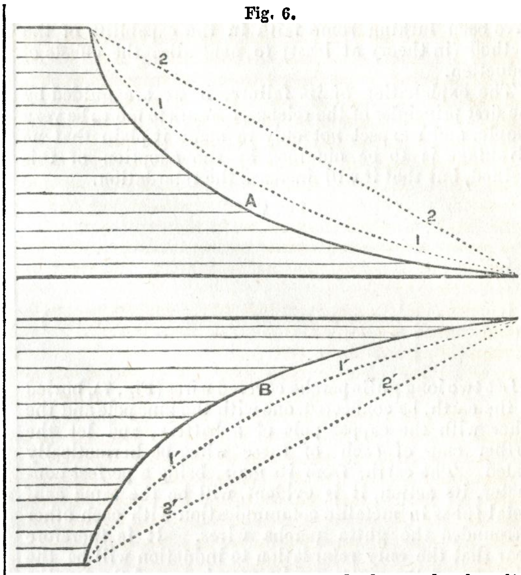
The next consideration is the part induction plays in submarine circuits of any considerable length.

In a submarine circuit the wire is insulated from the earth by only a thin layer of gutta percha; the conditions therefore are favourable for induction through the insulating material; the conductor itself, from its great length, opposes very great resistance, or, in other words, insulates to a very considerable extent.

When a battery is connected to send a current, the first impetus is in part directed forward, in part diverted laterally; but as the wire opposes considerable resistance to the passage of the electricity which the battery can generate, whilst the thinness of the insulating material is very favourable for induction taking place through it, the greater portion of the first rush will be occupied in charging the wire statically at the battery end; as, however, it is a balance of forces between the resistance which the wire opposes on the one hand, and the ease with which lateral induction can take place on the other, a very minute portion must pass through instantly, and the period which will elapse between the making contact with the battery and the observing the current at the further extremity will depend upon the capability of the instrument to record very small quantities of electricity.

In fact, immediately on contact being made with the battery, a wave will be formed throughout the length of the wire, somewhat like what is shown in the diagram (Fig. 6), which is intended to represent a submarine wire the moment after contact has been made with the battery.

Fig. 6.



The line A represents the internal charge having its maximum tension at the battery end, and diminishing in intensity as it approaches the farther extremity. The line B shows the induced charge of the opposite kind on the outer surface of the gutta percha, and forms an exact counterpart to the internal charge, with the exception of being a little less intense; for as it is spread over a greater surface, and only exactly balances the internal wave, its tension will be less in proportion as its surface is greater. As the tension of the statical charge is raised, so will the flow of electricity at the further extremity increase; both will arrive at their maximum together; the current will then flow in a regular stream as long as contact with the battery continues. The dotted lines 1 1 and 1' 1' are intended to represent the waves after the contact has been made a short time, and the lines 2 2 and 2' 2' are intended to represent the waves when they have attained their maximum height.

In the last case they will be perceived to be more regular.

When the battery has been disconnected from the wire, the opposite waves will still continue to unite, but the rate of flow as the tension falls will become slower and slower.

In theory the time which would be occupied by a wire discharging itself completely in this way would be infinite. In practice the wire requires a very appreciable time to charge, and a longer period to discharge. The effect of this is, that if currents are sent at all rapidly one after the other, instead of obtaining a series of distinct impulses at the further extremity, an undulating continuous current is received; and, as to obtain a telegraphic signal, the wire has not only to be charged to a certain degree of tension before an appreciable current is received at the further end, but has also to be discharged afterwards before another signal can be sent, the impulses which are obtained through such circuits as these are very sluggish.

The problem to be solved is the best means of reducing the amount of induction, and of mitigating its effects.

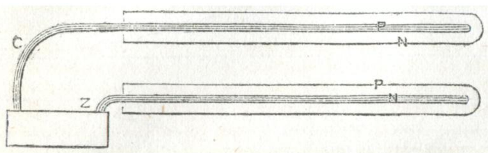
Almost the first remedy suggested when this inconvenience was experienced, was to substitute another insulated wire in the place of the earth for a return circuit, for it was argued that, as in this arrangement, one wire would be charged positively and the other negatively, they would neutralise one another.

This suggestion was put to the test and failed. Since that time the same plan has been revived by several others; a good deal of argument has also been brought forward lately in support of it, and even amongst those,

who know its practical inutility, there would still seem to have been lurking some faith in the capability of the method (in theory at least) to neutralise the effects of induction.

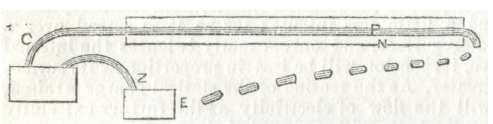
The explanation of its failure, if we are guided by the first principles of the science, appears to me to be very simple, and I expect not only to make it plain that no advantage is to be obtained by the adoption of this method, but that it will increase the retardation.

Fig. 7.



Let two long gutta percha covered wires (Fig. 7), buried in the earth, be connected, one with the zinc pole and the other with the copper pole of a battery, and let the farther ends of each of these wires be hermetically sealed. The earth, from its mass, being a perfect conductor, its action, it is evident, will be the same as if metal tubes in metallic communication with each other surrounded the gutta percha wires. It is therefore clear that the only retardation to induction will be the thickness of the gutta percha covering, and the tension of the statical charge will be in accordance with the intensity of the battery. Now consider the case of a similar gutta percha wire of the same length (Fig. 8) as one of

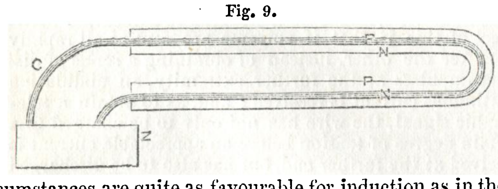
Fig. 8.



these, but in which one pole of the battery is connected to the earth and the other to one end of the metallic conductor, and the circuit completed by connecting the further extremity to the earth. It will also receive a statical charge to a certain degree, but the tension of the charge will not, *ceteris paribus*, be dependent upon the intensity of the battery, but upon the resistance which the wire opposes, for it has already been shown that this is the only real insulation between the wire and outer coatings, and that the degree to which statical charge can take place depends on the amount of insulation existing.

Now, let the ends of the two wires vhich are hermetically sealed be connected to each other (Fig. 9), the cir-

Fig. 9.



cumstances are quite as favourable for induction as in the wire in which one end was connected with the earth, but there will be twice the resistance; in other words, double the amount of insulation, and, consequently, a proportionate increase in the amount of induction.

Another view of this matter will perhaps assist to confirm what has just been stated.

It is a well established fact that when a telegraphic circuit is composed of a loop of wire, it will oppose the same resistance as a circuit of double the length where the earth is made use of in the place of a return wire, and this proves that the earth offers no appreciable resistance. If this be the case, what difference can it make whether the battery pole be carried to the end of the wire itself, or through the medium of any length of a perfect conductor, which the earth has been proved to be. Therefore, it would appear that the induction which would be manifested in a circuit composed entirely of an insulated conductor, would be the same as that in a circuit of twice the length, where one half the circuit is completed by the earth, and the only difference which would exist between the one and the other would be, that in a circuit composed entirely of wire, the statical charge will be distributed more uniformly throughout the entire length.

But, says a writer on this subject, I admit that no advantage would result if two separate wires are used, and which will therefore necessarily be some distance apart from one another, but place the two wires in the middle of a mass of gutta percha (Fig. 10), and so close to

Fig. 10.

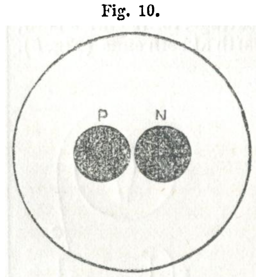
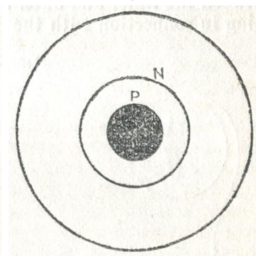


Fig. 11.



each other that they may become virtually the centre of a system, and let the insulating material be of considerable sectional area, then no induction worth naming will take place between the wires and the earth, and the inductive influence of the positive wire will neutralise that of the negative wire.

The fallacy of the proposition will be at once seen if it be carried out more fully. Instead of letting the wires lie side by side, let the one wrap over the other, and be, in fact, a tube with a thin mass of insulating material between it and the inner wire (Fig. 11). They will now become really the centre of the system, and fulfil completely the object desired by the author of this suggestion, but is it not evident that such an arrangement is the fac-simile of a Leyden jar, and will not the conditions be the most favourable that can be conceived for the development of induction?

The only remedy which has been successful in mitigating the effects of induction, is that of throwing into the wire, immediately after a current has been sent, another of the opposite kind; this absorbs and neutralises the preceding wave much more quickly than when the wire is left to discharge itself in the ordinary way. This method, however, does not reduce the induction, but only mitigates its effects, although in circuits of moderate length its adoption has, for practical purposes, completely removed the inconveniences arising from the induced charge.

There are only two ways of reducing induction, the one is to increase the thickness of the insulating material, and so render the conditions less favourable for its development, and thus approach the conditions of a suspended circuit, where the induction having to take place through a considerable space of air—a dielectric of very low specific inductive capacity—there is but little accumulation of statical charge, and consequently the impetus is almost entirely directed forward, and scarcely diverted laterally to any appreciable extent.

In gutta percha covered wires, when the insulating material is increased in size, it has been shown that the full effect of the increased thickness is not obtained, owing to the outer surface increasing at the same time.

There is also another quality possessed by resinous substances, and probably by gutta percha, worthy of consideration. It is the property of absorbing a charge in the mass of the substance, instead of its being confined entirely to the surface; the tendency of this will be to still

further reduce the advantage of an increased thickness of insulating material.

A reference to first principles will make this clearer.

All bodies insulate to a certain extent, and the only difference between a so-called conductor and insulator that would appear to exist, is a difference of degree, and if a charged body is brought into the neighbourhood of an insulated conductor, induction will take place through it in the same way as through a dielectric, but owing to the particles of conducting substances possessing the property of readily communicating their forces one to another, the inductive force developed at the further extremity will, within certain limits, be scarcely affected by the length of the conductor through which induction is taking place.

The absorption of a charge within the substance of the dielectric is an approach to this condition, but its practical moment when gutta percha is the insulating substance has to be determined by experiment.

Lessening the induction by reducing the resistance has next to be considered.

The first thing obviously will be to obtain a metal of the highest specific conducting power, for could the sectional area be diminished without increasing the resistance, the induction would be reduced proportionately to decrease in the surface. The next will be to increase the sectional area of the conductor, and although this involves increased surface, yet there will be a gain; for when the diameter of a wire is enlarged, the surface over which the amount of induction extends does not increase in the same ratio as the sectional area which determines the resistance opposed by a conductor. To make this clearer, let four cables ranged side by side be employed as one conductor.

Such an arrangement will possess four times the sectional area, and oppose only one-fourth the resistance; in other words, the same tension of current will force through four times the dynamic quantity of electricity that would be generated through the single cable when used alone. Signals would not, however, be transmitted more rapidly through the four cables than through the one, for although the conducting power has been increased four times, the surface has been quadrupled also, which will exactly counterbalance the lessened resistance; but merge the four into one, the external inductive surface will then be halved, whilst the sectional area will remain the same as before, and there will be only half the induction manifested.

It therefore follows when a wire is enlarged, that as the sectional area increases as the square, whilst the surface increases only in regular proportionals, the relative balance of forces in favour of rapidity of conduction will, in a submarine conductor of a given size, be twice the amount of that in a wire of half the diameter.

I would now attempt an explanation of how it happened that an actual retardation was observed in some of the experiments with the Atlantic cable when a conductor of enlarged sectional area was employed; and on this head I would again quote from my remarks on a former occasion:—

"In the experiments to ascertain whether any advantage would result from the use of an increased sectional area of metallic conductor, recourse was had to joining the cables side by side, the increased inductive surface which such an arrangement involved having possibly been overlooked. This will account not only for an increased speed not having been obtained, but for an actual retardation having been noticed. Electro-magnetic induction coils do not create electricity, they simply offer a ready means of converting electricity of low tension and considerable dynamic quantity into electricity of very high tension and small dynamic quantity. The quantity evolved by them is always smaller in proportion as the intensity is greater. Both cannot readily be obtained together, and if a very high intensity is required, the quantity must be sacrificed, unless the size of the apparatus is immensely increased. This difficulty has evidently been appreciated, as the induction coils used by the Atlantic Telegraph Company are of large size and great length, so as to obtain high tension with an appreciable dynamic quantity. Nevertheless, there is little doubt but that the quantity evolved even by these machines, when compared with that generated from voltaic batteries, is small. This being the case, on giving the current a larger number of channels to rush into, there is not enough electricity to fill the wires, consequently the tension of the current will be very much lowered. The effect of this will be that a longer time will elapse before the tension of the wire will be raised sufficiently high at the further extremity to render itself apparent on the instrument. To obtain, under such conditions, the same speed with four cables as would be obtained with one alone, it would be necessary to employ four of these induction coils, ranged side by side, and worked with four times the battery surface, so as to generate four times the dynamic quantity of electricity. When qualified with these conditions, under which, no doubt, the experiments were tried, the reasoning contained in the Atlantic Telegraph Company's pamphlet, given in an earlier portion of this paper, is correct. It is precisely a case of having four Leyden arrangements to charge instead of one. A telegraph cable is, in fact, a Leyden arrangement, which has to be charged to a certain degree of saturation, before signals are obtained. The degree to which it has to be charged, statically, depends upon the extent of inductive surface compared to the conductibility of the metallic core. In a circuit where the conductibility of the metallic core is very great, compared with the inductive surface of the insulating material, no high degree of statical charge can take place, and signals will pass quickly. The opposite effect will be noticed in a circuit where the inductive surface is very large compared with the conductibility of the metallic core. The wire will then have to be statically charged very highly, before a perceptible current will flow from the further extremity, and signals will be obtained proportionately more slowly."*

The reason why signals are found to pass when magneto-electric induced currents are employed in place of voltaic ones arises, I believe, not from any specific difference between them, but simply from the tension of the induced currents being very much greater than any voltaic ones which have been employed.

On this head I will say nothing further here, but would refer those who may take an interest in it to my paper of a former occasion, where I have fully entered into this subject, and also attempted an explanation of how it has happened that in the experiments with voltaic currents, of varying intensities, no difference of speed has as yet been observed.

The amount of retardation which will be experienced in submarine circuits possessing conductors of varying resistance, and insulated with different thicknesses of insulating material, it appears to me can, comparatively speaking, be readily determined by actual experiment.

I have for a long time been engaged in designing an apparatus for this purpose, and at the time I arranged to give this paper, I fully expected to have had the apparatus completed by this time, and to have been able to have laid it before you on this occasion; and, though I regret not being able to do this, yet I feel I have sufficiently advanced to warrant my explaining the principles of its construction.

The principles upon which it is based are: that a body which offers the same resistance as another, without reference to its substance or length, may, as far as conducting power is concerned, be considered electrically the same. If we make use of a substance or metal of any inferior specific conducting capacity to that of the metal

* *Vide*, "The Atlantic Telegraph."

employed in submarine circuits, and also of greatly diminished sectional area, the same resistance as that offered by the very longest circuits can be obtained in a very small compass; and such an arrangement will, as far as simple conducting power is concerned, fairly represent a long submarine circuit.

The induction which manifests itself in submarine circuits can also be obtained if the conditions for its development are as favourable as they are in submarine conductors.

The apparatus consists 1st., of a series of resistances, the values of which are known.

2nd. Of a series of induction plates, the values of which, when compared with a given surface of a gutta percha coated wire are also known.

3rd. A mechanical arrangement to accurately measure minute periods of time.

By a combination of the resistances and the induction plates, a conductor, which will fairly represent a submarine circuit, will be obtained.

The resistance can be diminished or increased, and the inductive surface can be doubled or halved at pleasure, and thus circuits with conductors of varying lengths and sectional area, and different thicknesses of insulating material be imitated, and the law which governs the retardation in the transmission of telegraphic signals determined by direct experiment.

It may be argued that as the inductive surface in a telegraphic circuit is uniformly spread throughout, a series of induction plates will not present the same conditions, but it is evident that they may be divided throughout also, and although they will not then precisely represent what is actually the case, the result will approximate very closely to those obtained from a submarine conductor.

Perhaps it would have been prudent not to have called attention to an apparatus before its completion. I have done so, however, because I have felt it was due from me to endeavour, at least, to point out how some of the important problems involved in submarine telegraphic communications between distant stations may be resolved.

The chief deductions from what has been brought forward in this paper are :—

1st. That the metallic core of a submarine cable should be composed of a conductor of the highest specific conducting capacity.

2nd. That a decrease in the retardation which is caused by the induction that takes place in submarine circuits, can only be obtained by increasing the thickness of the insulating material, but that it will be better to do this by enlarging the sectional area of the conductor as much as is practicable.

In designing a cable there are many considerations besides those of its simple electrical qualifications which have to be entertained. The object to be obtained is the best result with the most economical investment of money. Are the proportions which were adopted in the Atlantic cable the best to ensure this?

The weight of the conducting coil in this cable is about 63lbs. to the mile, the value of which, speaking roughly, would, I suppose, be about as many shillings. When served with gutta percha its value was raised to £40 per mile. The iron sheathing and getting the cable on board brought its value up to £100 per mile. The expenditure, however, did not cease here; there was the hire of ships, salaries of staff, &c., &c. In this cable, therefore, only four per cent. at the outside was invested in the conductor upon which the transmission of the messages depended.

If the views which I have brought forward are correct, a conductor of double the diameter would only produce half the amount of retarding force of one of half the size. Such a conductor, at the very outside, would not cost more than £16 per mile, and the increased expenditure, in serving such a conductor with gutta percha, and giving it an iron sheathing, would not, comparatively speaking, be very large; the expenses of the staff and the hire of ships would be about the same in both cases; the latter would be, perhaps, increased slightly, but not to any material amount.

There are a great many other points which should be entertained in such a paper as this, but the paper has already run out to such a length that I will not trespass any further on your patience; and in conclusion I would only add, that if the ventilation of the subject, through the medium of this communication, should tend in any way to the progress of Electric Telegraphy, the object of its author which have been obtained.*

DISCUSSION.

The Chairman, in inviting the electricians present to take part in the discussion, would call their attention to the generally-scientific character of the paper, although there was a passage towards the close of it which opened up a practical question of great importance. Even if this had not been so, he thought in a society like this, where they dealt generally with the practical application of scientific principles, he would have been justified in inviting gentlemen to enter more particularly into the practical application of the theory which had been so ably brought before them. He would call their attention especially to one view which had been expressed very clearly with regard to the difference which existed between the Leyden jar and a long line of insulated wire with a distant termination connected with the earth. Mr. Varley had put before them what insulation practically was in such a case. It was not the separation of a body in an electrical state entirely from all surrounding substances, but the amount of resistance offered by the long wire before it terminated in the earth. This distinction had been brought before them in a very lucid manner, and he thought they were much indebted to Mr. Varley for having done so. He hoped gentlemen present would give their ideas as to the proportion of metallic conductor that should be used in long lengths of submarine cables, such as that between this country and America; also as to the mode in which the conducting medium should be constructed—whether of a single or a compound wire. This, however, was not the whole question; they had to consider not only the thickness of the wire and insulator, but also whether the insulating substance —gutta percha—was the best that could be adopted for the purpose, and whether before the next great experiment was tried with an Atlantic cable, they could not obtain further light with respect to the insulating medium that was best adapted to a length of cable of that description, both as to cheapness and the power of resisting the pressure of the water, although he thought cheapness in that part of the conductor was a matter of minor importance. It appeared that the conductor itself was only 4 per cent. of the whole cost of the last great experiment to America. The additional cost of the conducting medium, even to the extent of 8 or 10 per cent. was not to be considered for a moment, but the point was, whether by increasing the dimensions of the conducting medium, they did not at the same time increase the amount of induction. He should be glad to hear the views of Mr. Walker on this subject, as that gentleman's experience would be most valuable.

Mr C. V. Walker had attended to listen and learn, ather than obtrude his own views upon the meeting, but, reing called upon, he would offer a few observations. The

* See excerpt minutes of Proceedings of the Institution of Civil Engineers, Vol. xvi., Session 1856-57.

See "The Atlantic Telegraph. A History of Preliminary Experimental Proceedings, &c., published by order of the Directors of the Company," pages 20, 23, 25, 26, and 40.

See also the *Engineer* of December and January, 1858-59. "A discussion on the Induction in Submarine Circuits, by X. Y. Z., G. Blair, M.A., Telegraphic Engineer, and J. Tatlock.

difference which Mr. Varley remarked between the Leyden jar and a submarine cable, was that which was generally recognised; it was simply a difference of degree as to the relative states of the inner and outer coating. The cable did practically possess all the distinctive character of the Leyden jar, notwithstanding that the inner and outer coatings were connected, as the experiments made with the Atlantic cable illustrated. The experiments worked out in the early part of the paper to determine the law of induction, would be found very clearly laid down by Sir William Snow Harris in the little book published by Weale. He had shown that the law of induction was inversely as the distance, and directly as the surface. The next clause of the paper referred to "intensity." This term had led to much confusion; moreover he thought in the present state of electrical science the conditions regarding conduction were far more completely expressed by the formula of Professor Ohm, than by Mr. Varley's diagrams. Another question in connection with submarine cables was the size of the conducting wires. This was a very important one, and he was quite sure they would think he was possessed of very little modesty if he ventured to give judgment upon a matter which, in his opinion, was so entirely a question of experiment that he only wondered the great cable was laid down before this important point had been satisfactorily investigated, so as to put the matter beyond the possibility of question, whether that conducting strand of seven wires was too large or too small. An opportunity occurred to him to try some experiments with seven or eight distinct miles of insulated wires of different sizes and different thicknesses of gutta percha insulation. The wires were in lengths of about one mile each, and the results of those experiments were decidedly in favour of a small wire as the conducting medium. There were many points in connection with small wires worthy of consideration, one of which was cheapness, because, although the per centage of saving upon a mile of wire was small, yet the saving would be very great in a cable to extend across the Atlantic. The smaller the wire was the greater the insulating power obtained from the same amount of gutta percha. The alleged advantage of the smaller wire was, that there was a greater resistance in the circuit; but, in the pamphlet published by the Atlantic Telegraph Company, the experiments made by Mr. Reid were described, from which it appeared that he sent a signal through 1,000 miles of cable with a battery of two plates only, excited by his tongue, so that the resistance to be overcome by that small battery could not have been great. Another point was the return wire, and upon that he considered the whole question of the Atlantic cable turned. What helped them on the one hand hindered them on the other. The effects of the magnetic disturbances of the earth would be obviated by a return wire. If two lines of cable were laid down and the current passed to Newfoundland by one wire and returned by the the other this inconvenience would be got rid of, but they would have the other inconveniences which Mr. Varley had laid before them. If the two wires formed portions of the same cable they would cause a greater amount of retardation, because one wire would polarise the other. But if two wires were used in the same cable in a somewhat different fashion, namely, if one was laid as the centre wire, and the other carried spirally round it, and the current divided between the two wires, the polarisation would be very much reduced, if not entirely annihilated. Those two wires, however, would act externally upon the outer coating, which would render the advantage nugatory. In his opinion the next Atlantic cable would not be coated with an iron jacket, as the former one had been; but a coating of hemp and other non-conducting materials would be employed. It might be interesting to the meeting to know the time it actually took to send signals through the Atlantic cable. By Whitehouse's induction coil it took $1\frac{3}{4}$ seconds, whilst the battery current was 6 seconds in its passage through, at least as far as he recollected.

Professor Tyndall said that the paper displayed a considerable amount of research, and an extensive acquaintance with the ordinarily accepted laws of electricity, as well as with the phenomena of retardation and induction. He would express the feeling that beset him, as he heard the paper read; and he spoke with all frankness and all respect to Mr. Varley and those, who, like him, were engaged in these researches, when he said that knowledge such as had been displayed in this paper, ought to be somowhat like the manure that was applied to agricultural purposes: it ought to be put underground, and new fruits ought to sprout from it. He had been looking intently for the results of this knowledge which had been brought before them; some of it was interesting, but, for the most part, it did not deal with facts, but rather with conjecture, more or less ingenious. The whole subject involved a complicated problem. There was not a shadow of doubt that each element of it could, by proper experiment, be separated from the rest, and its due influence described with certainty; and this was what ought to be done, instead of speculating upon the laws of electricity. He thought those speculations ought to be the private property of the man who worked the subject; they ought to guide him in his searches after facts; and if he produced the facts, he could then show the connection there was between the facts and the first principles of the science. He would refer more particularly to what he should himself like to see done. He had heard remarks about thickening the wire and the surrounding insulation. He would ask had any particular experiments been made to ascertain the law of, or the benefit to be derived from, thickening the wire? Had experiments been made to determine the law by which retardation was diminished, when the thickness of the gutta percha coating was increased? They could take the absolute wires that were to be used, and cover them with gutta percha and india-rubber, and compare them, and they could tell with certainty which was the best insulator. They could tell the influence of the thickness of the wire, and the thickness of the insulator; and he thought their knowledge of the principles of electricity ought to be the guiding light to carry their minds to the determination of these cardinal points.

Mr. Cromwell Varley said he could answer some of the questions put by Professor Tyndall. He had consistently recommended to the Electric and International Telegraph Company the use of wires of large diameter, for the last twelve years, as the only means of obviating the difficulties experienced on long circuits in wet weather from leakage, which, with the earlier forms of insulator used, was very great. Since the introduction of submerged wires he had pointed out the advantage that would be gained in such circuits of great length by the use of copper wire of large sectional area. On his recommendation the directors of the above-named company had tried both of these experiments on a large scale. They had erected iron wires of No. 3 wire gauge on the London and North Western Railway, on the Great Western, and the London and North-Western Railways instead of the usual size (No. 8). The results were such that he had no doubt they would never again, for long circuits (viz., of over 200 miles in length), erect other than thick wires. They had tried thick wire under the sea in their new cable connecting England with Holland. This cable contained four conductors of No. 13 instead of No. 16 wire, and although, for reasons explained further on, the relative speed of this compared with that of the former size was not so great, yet there was a very decided gain in rapidity, together with much stronger and much more uniform and reliable currents. These wires were connected both in England and Holland with a considerable length of overground wire, which latter was much affected

by changes of the weather, and the gain in unfavourable weather from using the larger wire was, as predicted, very considerable. He was very much surprised to find Mr. C. V. Walker adhering to, and supporting, views which other well-known electricians had put forward, viz., that increasing the sectional area of the wire did not increase the rapidity of the transmission of electric signals. The experiment, however, had been lately tried in the new Dutch cable, and although the relative speed was not exactly known because there were many difficulties in the way, yet the fact was established that increasing the sectional area had greatly increased the speed. He had tried to determine the effects of induction, &c., on the speed of the electric wave; not only had the inductive effect to be taken into consideration, but also the absorption of electricity by the surfaces of the dielectric, and these influences were ever changing by heat and by the charging of the wire to such an extent that approximate results only were obtainable, which, however, were sufficiently near for all practical purposes. The absorption of electricity by the surface of the dielectric required time, and therefore cables of such length and dimensions as would only work slowly, suffered more from this absorption than shorter and quicker ones. The retardation of the wave in a cable was caused by the lateral induction absorbing part of the electricity intended to give the signal through the line, and until this charge approached the maximum the current at the distant end would be weak. If two cables were made, the one with an iron and the other with a copper conducting wire inside the gutta percha, all other things remaining the same, the former would have as much induction as the latter, because this had reference only to the surfaces of the dielectric. As the iron wire would only conduct at one quarter the speed of the copper, it would require, with a given electro-motive force, four times as long to transmit a given current. The electricity would require, in the case of the iron wire cable, four times as long to charge the gutta percha, by lateral induction, as the copper-wire would, consequently such a cable would have only one quarter the speed of the other. Were it possible to compress twice as much copper into the same diameter, and so double the conducting power without increasing the inductive surfaces, the speed would be immediately doubled. This was not possible, and the effect could only be obtained by increasing the sectional area of the wire; increasing this four times, doubled the interior surface of the gutta percha, which was the chief inductive surface, and, leaving out of consideration for a moment the exterior surface, the conducting power would be quaprupled while the induction was only doubled; hence there would be a gain in speed of from 1 to 2. But there was more still than this gained; first, suppose the diameter of the small wire to be unity, and the thickness of the gutta percha covering also unity, the exterior surface of the gutta percha would be 3, and the combined surfaces of the gutta percha would be $3 + 1 = 4$. In the second case, where the copper wire was doubled in diameter, and quadrupled in weight, there would be two for the inner surface of the gutta percha, and four only for the outer surface, instead of six—collectively, six instead of eight. Hence, doubling the diameter more than doubled the speed. The third gain from the large wire was, that, having a higher speed, there was less time for the absorption of electricity, and, consequently, the disturbance and retardation from this cause were less. Having a current of four times the power entering the cable, and the leakage being less in proportion to it, the current received at the distant end would be more than four times as powerful, and much more regular; the apparatus would be less frequently interrupted for adjustment, and would, consequently, work without intermission for a much longer period than the smaller wire. Mr. Walker had alluded to the Atlantic cable, and stated, in proof of the sufficiency of the diameter of the copper wire, the fact that a single element of water battery gave a current perceptible at the other end. He (Mr. Varley) contended that this proved nothing as to its ability to transmit intelligible signals. In an Atlantic cable we must have not only a wire capable of giving currents and signals, but of giving such currents and signals as should overcome the friction and inertia of the apparatus used for indicating them; these currents must be so powerful and constant, that, when the philosopher had left the cable to the ordinary manipulator, the currents should not fluctuate so much as to interrupt the intelligibility of the communications. The current must have such force, that the varying friction of the apparatus should not materially influence the recording of signals. In the Atlantic experiment these difficulties were overcome to a great extent by a most ingenious little instrument—Professor Thompson's reflecting galvanometer. In this instrument the only friction was that of a single thread from a silk cocoon, supporting a very short magnetic needle, only $\frac{1}{3}$ of an inch in length, which carried a small mirror made so light as to weigh only a grain or two. The mirror reflected back through a lens a ray of light, and thus without impeding its free action, or adding to its friction, a long but imponderable arm was added to the needle to magnify its motion. This little needle was rendered more or less nearly astatic, by placing a large magnet under it to neutralise the earth's magnetism, and thus a nearly astatic instrument, sufficiently rapid in action from its small dimensions, sufficiently sensitive by its long imponderable arm (or ray of light), sufficiently free from friction by being suspended from a filament of silk, was obtained, and by it the faint signals through the cable were rendered visible. These signals were watched by a clerk, and recorded by hand on a Bain's printing machine. He (Mr. Cromwell Varley) felt that sufficient credit had not been given to Professor Thompson for this instrument, without which the Atlantic cable would never have transmitted a single message, and the world would not have had this great experiment to guide them, as there would have been no means of ascertaining whether the cable had reached the bottom of the Atlantic without parting. Such an instrument, however, was not calculated to meet the requirements of a commercial undertaking, because the reflected spot of light was difficult to follow with the eye for any length of time, and was often recorded by the manipulator incorrectly. The current must have sufficient force to record itself. With regard to the insulating properties of gutta percha, when pure and free from moisture he had found it to rank amongst the best dielectrics, but this was not the condition of the gutta percha used on cables, which appeared to be porous and to contain moisture. When the gutta percha was sufficiently heated to free it from this, there was great danger of altering its character, and rendering it liable to become brittle and to crack. In the Atlantic cable, even before it had been put under water, the loss of current by leakage was so considerable that less than one-third of the original current only reached the distant end. Were the loss constant in quantity it would not so much matter, but wherever the current escaped through moisture, there was polarisation and ever-varying resistance at the leaky spot. As an example, he would quote one of many similar cases that had come under his notice. In one of the London and Liverpool wires, there was a defect in the Kilsby tunnel, caused by a filament of wood in the gutta percha, which was wet at this spot. This leak gradually got worse and worse, and sometimes offered a resistance equal to ten miles of the line composing the circuit, and at other times, especially after the continuous passage of a positive current for some length of time, it offered a resistance equal to more than a thousand miles of the circuit. The fault was situated nearly half way, roughly speaking, 100 miles from the end, and when it offered a resistance of only 10 miles, $\frac{1}{11}$ only of the current from London

reached Liverpool, assuming the rest of the line perfectly insulated. When the fault from polarisation, &c., offered 1,000 miles resistance, the current which reached Liverpool was $\frac{10}{11}$ of that which left London; these fluctuations sometimes took place in a second of time. The formulæ for such a case was $e = \frac{E\,l}{l+y}$, where e was the current received at the distant end, E the current leaving the original station (London), l the resistance of the leak, and y the resistance of the line between the leak and the receiving station. Now in the former case, the current was amply powerful enough to work the instruments, and no inconvenience would have been experienced had the fault remained constant, but on the contrary, it was always varying in force, and to such an extent that it was impossible to work the line through only 200 miles in length. Thus it would be seen that, leaving out of the question induction, and its consequent diminution of speed, a conductor of sufficient size must be had to cause these leaks to bear only a small proportion to the current transmitted, in order that the received signals might be sufficiently regular and equal in force to record themselves with certainty and ease. Unless these conditions were attended to, the cable, as a commercial undertaking, would inevitably fail. With regard to the rapidity of conduction of the electric current, his opinion was that the current began to flow from the distant end *immediately* after the near end was connected to the battery. Electricity showed no signs of compressibility or elasticity, and was without inertia. Suppose, for a moment, that a cable was divided into several portions, each of which was without appreciable resistance, but separated from the next portion by a given resistance, the first portion, on coming in contact with the battery, would be instantly charged, and as instantly would begin charging the next portion, but to a lower degree than itself; this second portion as instantly charged the third portion, to, of course, a still lower degree; and this the next, and so on to the end. By careful reasoning on the known laws of electricity he had come to the conclusion that the current began to flow out of the distant end instantly, but so feebly at first that the most delicate instruments failed to show it. Before concluding, he would draw attention to the unhappily chosen terms "quantity" and "intensity." What in England was generally understood by "quantity," was in Germany termed intensity or I. What in England was termed "intensity" or tension, was the electro-motive force; in other words, the $I = \frac{E}{R}$, where I represented the power of the current to decompose a given quantity of an electrolyte, E the electro-motive force of the current, and R the resistances of the circuit. These terms had unfortunately led many into error, more especially the word "intensity."

Mr. C. W. SIEMENS agreed with much that had been said in the paper. He was decidedly in favour of a large conductor of the very best specific conducting power; and had maintained from the first that the conductor of the Atlantic cable was totally inadequate. When he read a paper last year before this Society, he had expressed the laws by which the proportion of an electric cable should be regulated for a given length by a simple formula; and he thought that a mathematical expression properly explained was preferable to an explanation in words only, even for a popular assembly like the present, because it combined all the elements to be taken into consideration. He did not agree with Mr. Varley that an electric wave on entering a submerged conductor at one end presented itself, in however slight a degree, instantaneously at the other. The laws of induction and conduction, as he understood them, were directly opposed to such an assumption; and in his own experience he had certainly never observed any indication of it. The line expressing the relative amount of charge at different points of the electric wave in the conductor, was expressed not by a dynamical curve, as Mr. Varley had shown it, but by a straight line, terminating abruptly upon the horizontal line which represented the conductor. Another portion of the paper dealt with the complete metallic circuit in submarine conductors, which it was generally understood had been first proposed by his (Mr. Siemens') brother. Mr. Siemens could not agree with the views expressed by Mr. Varley, and by several others who had lately written in the scientific journals upon this subject. Some of them seemed to lose sight entirely of the most essential condition, namely, that the two conductors were to be embedded in the same insulating medium. His brother had never for a moment assumed, as seemed to be supposed, that lateral induction between the two conductors constituting the circuit would be obviated. On the contrary, it would be rather increased on account of the greater resistance of the metallic circuit. But it was maintained that the charge between the conductors and the larger surface of the sheathing would be nearly entirely obviated; that the working of one metallic circuit in a multiple cable (which his brother had chiefly in view) would not disturb the electrical equilibrium of the other conductors; that the losses by leakage would be reduced, enabling him to reduce also the area of the conductor, and thereby also the lateral induction between them, that the metallic circuit was not affected by magnetic storms, and finally that considerable advantage could be obtained by the mutual acceleration of the positive and negative currents by Volta induction. So long as a single conductor could satisfy the public demand for messages, the advantages of a metallic return wire would probably not warrant the additional expense, but wherever several conductors became necessary, the advantage of working through metallic circuits would be very great. Mr. Varley's illustration of surrounding the one conductor by the other (in the form of a tube) did not meet the case, because the tubular conductor possessed the very condition which it was intended to avoid, namely, an extended inductive surface both against the inner conductor and the outer sheathing. Mr. Siemens had only one other point to remark upon, and that was of an historical nature. Mr. Varley had stated that Mr. W. Siemens had first employed gutta percha coated wires in Prussia in 1850, where he had observed the phenomena of induction also. It was, however, in 1847 when the first gutta percha coated line wire was laid down successfully near Berlin; and he (Mr. Siemens) exhibited specimens of it, and explained the phenomena of charge which had been observed, before this Society in 1848. He might also observe that the statements which had been circulated, that the gutta-percha coated wire, as first prepared in Prussia, had proved an entire failure, were very unfair towards his brother. These wires had been coated in the same manner as they were at the present day, although it must be admitted that the quality of the gutta percha employed was very inferior. These lines had, however, done good service for four or five years, when they began to fail; some of them had, however, lasted much longer, and some—covered with lead—were actually in use to the present day. He did not think that a much more favourable result had since been obtained elsewhere.

Mr. LEONARD WRAY said he would make but a few brief remarks upon some of the points under discussion. In the first place he considered that the paper read by Mr. Varley was a very valuable and instructive one, for which all present must feel indebted to him. Let the ideas brought before the Society that evening be designated as mere conjectures, or theories, or what not, still he ventured to differ from Professor Tyndall's opinion, that Mr. Varley should have confined them to his own breast until he had fully tested and proved them practically, inasmuch as Mr. Varley, by giving publicity to them before that Society had, in fact, laid them before the whole world of science, and the result would be, that instead of these ideas remaining stored up in his

own mind alone, to be worked out solely by his own individual energies, there would now be many, very many, minds brought to bear upon them, and to assist in reducing them the more speedily to the test of practical experiment. The next point he would remark upon was the best diameter for the conductors of electric telegraph cables, a subject which was so very much discussed, and so very much disputed, that he would only present to the notice of the Society one very singular and significant fact bearing upon the question. When telegraph wires were first introduced into India, Sir W. O'Shaughnessy and his staff were sadly annoyed by the continual breakings of their wires, caused by very large birds alighting upon them. To remedy this nuisance that gentleman employed very thick, strong wires, which these birds could not injure; and this great increase in the size of the wires brought out the remarkable fact that no insulation whatever was necessary at the posts, around which they were simply wound. This deserved, he thought, to be recorded in such a discussion as the present. The third and last subject to which he (Mr. Wray) would refer, was that of insulation. Now, the substance almost universally used as an insulating material was gutta percha; but they were told, and many of them knew it as a fact, that gutta percha absorbed no inconsiderable quantity of electricity; indeed, that it became, to a certain extent, saturated with it. Such being the case, it must be evident that gutta percha was by no means a perfect insulator, for he held it as an axiom, that no really good and perfect insulator would absorb electricity. The greater the quantity of electricity absorbed by the insulating material used, the greater would be the retardation of the current. Hitherto, then, a substance had been employed which was very far from perfect, and all calculations had been based upon its known insulating properties; but if they had a superior—a very much more perfect insulating material—would it not be possible to construct cables with a far less quantity of that material than gutta percha? He thought so, and he moreover believed that such an insulating material as he had spoken of would, very probably, be soon discovered.

Mr. S. Alfred Varley said he had but little to reply to, as no attempt had been made to refute the views he had brought forward. He was unable to follow Mr. C. V. Walker throughout, and he did not clearly see the direction in which his views tended. Mr. Walker appeared to object to the statement made, that there was a difference between an ordinary Leyden jar and a submarine circuit; yet he admitted that the conductor united the inner and outer coatings of a submarine w ire when regarded as a Leyden arrangement, and that the resistance it opposed was the only thing which prevented the free flow from the one to the other; now he (Mr. Varley) thought this was a most important admission, for upon it depended the reason why a large wire conducted more rapidly than a smaller one, and this was no longer a theory, but an ascertained fact. If there were no difference between a submarine wire and an ordinary Leyden jar, and if a submarine circuit had to be charged statically to saturation before signals passed, as was stated to be the case by the advocates of the small wire system, then it would be clear that as the greater the sectional area, the larger the Leyden arrangement would be, there would be more retardations with larger conductors, as more electricity would be required to charge them. He maintained that, in practice, a submarine circuit was not charged to saturation; the degree to which it was charged statically depended upon the relative balance between the conditions which favoured induction and conduction; if the conditions, as had been stated in the paper, favoured conduction, there would be less statical charge, and a greater proportion of the electrical impulse would be directed forward, and signals would be obtained more quickly. He fully concurred in all the views expressed by Professor Tyndall, and quite agreed with him as to the desirableness of searching for facts with actual submarine circuits of varying dimensions; but when these were not at command, he thought we should not wait for such favourable conditions for experimenting, but should endeavour to obtain the best substitute we could. Moreover, if it were possible to obtain all the conditions which submarine circuits presented in our own private laboratories, this would be a positive advantage, for the whole being under immediate command, and not disturbed in any way by atmospheric causes, more or less defective insulation, or other disturbing influences always occurring more or less in practice, we should be enabled to trace out principles more clearly and have fewer sources of error to eliminate. Mr. Siemens, when considering the question of the complete metallic circuit *versus* the earth for one-half of it, objected to the fairness of the diagram in which one of the conductors was made into a tube. This diagram was introduced, as was stated in the paper, as an exaggeration, simply to show the fallacy of the principle; and although, as was stated by Mr. Siemens, the wires would not, when side by side, present as much surface to induction as an ordinary circuit, yet it must be borne in mind that there would be just twice the resistance of that which would be opposed when the earth was employed for one-half of the circuit, and this would more than counterbalance the lessened surface exposed to induction. He agreed generally with the remarks made by Mr. Wray. There was no doubt that with large conductors imperfect insulation was less felt, but the result in Sir W. O'Shaughnessy's case was probably not altogether due to the size of the conductor, for it must be remembered that the climate was very hot and dry. As a practical fact, he (Mr. Varley) would state that when in the Crimea they never obtained what telegraphists termed a "perfect earth." In the submarine circuit between Varna and Constantinople, contact with the earth was made by connecting a wire to the iron sheathing of a piece of the cable, more than a quarter of a mile in length, which was buried in the earth, and passed through the British Embassy grounds, yet, notwithstanding this extensive surface, in hot weather he found the earth, to use a telegraphic expression, very far from "perfect," and he remedied this by carrying a wire out into the Bosphorus.

The Chairman said, before proposing the usual vote of thanks, he would express his opinion of the result of the discussion that evening. They had advanced very little in practical knowledge since the failure of last year with the Atlantic cable; but the proper way of doing so was to follow the course pointed out by Professor Tyndall. At the same time he thought it was well that theories should be advanced with a view to set men thinking; but the professor no doubt meant to pay Mr. Varley the compliment that his knowledge of this matter would be better applied to the practice than the theory of the subject. But Mr. Varley was, in fact, doing what had been asked of him; and it was only owing to some delay in the completion of an elaborate instrument that he was not able to lay before them the results of actual experiment. The *experimentum crucis* was what they really wanted; wires of different conducting powers tested against each other, and the results ascertained by the best class of instruments, and, he would add, by a variety of experimenters. He found that electricians still remained true to their colours, in the absence of positive results, one way or the other. His friend Mr. Walker still adhered to the small wire, whilst others appeared as the consistent advocates of a large wire as the best conducting medium. In this country, such opportunities were presented for experiment upon a large scale, that they had nothing to fear from theory; and he hoped such experiments would be made as would solve many of the points upon which so much diversity of opinion now prevailed. He would now propose a vote of thanks to Mr. Varley for his able and interesting paper.

The vote of thanks having been passed,

Mr. Varley acknowledged the compliment. He said he had taken up the subject from an earnest desire for the progress of the science, and from a strong feeling that great errrors had been introduced with regard to the Atlantic Telegraph cable, which, coming from those who had had such extraordinary opportunities for experiment, were likely to mislead.

The Secretary announced that on Wednesday evening next, the 6th April, a paper by Mr. George Wallis, "On Embroidery by Machinery," would be read.

Home Correspondence.

ARTS AND MANUFACTURES EXHIBITION IN THE WEST OF ENGLAND.

Dear Sir,—The facts that H.R.H. the Prince Consort has become a member of the "Bath and West of England Society for the Encouragement of Agriculture, Arts, Manufactures, and Commerce, founded 1777 A.D.," and that the Committee of Council on Education have made a special exception in favour of the Society, in order to allow the selection of decorative works of art from South Kensington Museum to be exhibited at the North Devon meeting at Barnstable, may justify me in asking you to allow me again to invite the attention of the members of the Society of Arts to the objects of that meeting.

The Council of the Society, building on the steady progress of their agricultural gatherings, on the increased business done in the sale of agricultural implements, on the improved demand for education and scientific instruction, which has arisen in the west of England, and on the complete organisation and harmonious action of the Society, have opened a new department of "Arts and Manufactures" for exhibition and sale. A special fund has been raised for a moveable building, to be used next year at Dorchester; an admirable plan has been furnished by Mr. Nicholson, Agricultural Engineer of Newark; and the support of the principal local dealers and manufacturers has been obtained.

The idea of the Exhibition, confessedly a novel one, gains ground in public estimation. It is recognised as not only good, but practicable. The idea is this, that the summer gatherings of thousands of persons attracted by the sight of live animals, steam ploughs, poultry, and music, may be made to minister to improvement in taste, if good and beautiful objects are placed before the visitors.

The migratory meetings of the British Association for the advancement of science, of the Royal Agricultural Society, the local examinations of the Universities and of the Society of Arts, have all tended to show that the civilizing action of railways must, in order to produce full results, be centrifugal as well as centripetal; and that a pleasant holiday in the country is appreciated by many hard-working townsmen, who are not directly interested in the business of the meeting.

All that is wanted is a little energy, a little common sense, and a pervading spirit of harmony and goodwill among the managers of the first experiment. If the plan is a good one, and well worked out on a moderate scale, it is sure to be supported, and will be followed elsewhere.

Encouraging replies and promises of articles for exhibition and sale have been received from the metropolis, from the Midlands, and from the North of England. The arrangements for protection and the charges for space appear to give satisfaction, being met on the part of exhibitors by a candid and liberal appreciation of the facts of the case.

Pottery, glass, metal work, and wood work, in their most attractive forms, will be well represented. The same may be said, so far as patterns are concerned, of textile fabrics; but the scale of the Exhibition hardly admits of the exhibition of pieces of cloth or prints, nor is there perhaps the same need for special efforts in these departments.

There will be an exquisite exhibition of water-colour drawings and sketches; the artists of the West of England need not fear comparison with all England. But in addition to the works of living artists, collections of the most precious kind, including works of Turner, and other eminent artists, such as few have an opportunity of seeing, will be opened to the public in a manner which reflects the highest credit on their possessors.

The exhibition will open on the 30th of May, and last for the week. Alas! it is the week of the Derby; but we have entered, and now we must run.

The entries close on the 16th April. Forms of entry may be had on application to Mr. George Down, Honorary Secretary, Cathedral-yard, Exeter.

I am, &c.,
THOMAS DYKE ACLAND, Jun.,
Chairman of the Arts and Manufactures Committee.

Sprydoncote, Exeter, March 28, 1859.

MEETINGS FOR THE ENSUING WEEK.

Mon. ......London Inst., 2. General Monthly Meeting.
London Inst., 7. Mr. John Ella, "On Chamber, Orchestral, and Ballet Music."
Entomological, 8.
Brit. Architects, 8.
Medical, 8.

Tues. ......Royal Inst. 3. Professor Owen, "On Fossil Mammals."
Civil Engineers, 8. 1. M. Alphonse de Brussaut, "On a New System of Axle-boxes and Journals for Machinery without Oil." 2. Mr. B. McMaster, Assoc. Inst. C.E., "On the Permanent Way of the Madras Railway."
Pathological, 8.
Photographic, 8.

Wed. ......London Inst., 3. Mr. E. W. Brayley, "On Meteorology."
Society of Arts, 8. Mr. George Wallis, "On Embroidery by Machinery."
Geological, 8. 1. Dr. T. Wright and Mr. R. Etheridge, "On the Inferior Oolite of Gloucestershire compared with that of Yorkshire." 2. Mr. E. Hull, "On the South-Easterly Attenuation of the Lower Secondary Rocks of England."
Pharmaceutical, 8.
Royal Soc. Literature, 8½.

Thurs .....Royal Inst., 3. Prof. Tyndall, "On Pneumatics."
Royal Soc. Club, 6.
London Inst., 7. Professor Bentley, "On Vegetable Substances used for the food of man."
Antiquaries, 8.
Linnæan, 8. 1. Mr. Barter, "On the Vegetation of Western Africa." 2. Dr. James Salter, "On the Cranial Characters of a Rat new to the British Fauna." 3. Dr. Salter, "On the Moulting of the Lobster and Shore Crab." 4. Dr. Sandwith, "On the Habits of the Aye-Aye."
Chemical, 8. 1. Dr. Odling, "On the Atomic Volume of Lithium." 2. Mr. N. Tate, "On some Experiments with Boracic Acid."
Artists and Amateurs, 8.
Royal, 8½.

Fri.........United Service Inst., 3. Capt. Chesney, "New Zealand considered as a Field for the Emigration of Military Men."
Astronomical, 8.
Royal Inst., 8½. Mr. James Paget, "On the Chronometry of Life."

Sat. ......Asiatic, 2.
Royal Inst., 3. Mr. J. P. Lacaita, "On Modern Italian Literature."
London Inst., 3. Mr. E. M. Brayley, "On Meteorology."
Royal Botanic, 3¾.

PARLIAMENTARY REPORTS.

SESSIONAL PRINTED PAPERS.

Par. No.

Delivered on 26th and 28th February, 1859.

50. Local Acts (15, South Wales, Pembroke, and Tenby Junction Railway; 16, London Bridge and Charing Cross Railway 17, Lancaster and Carlisle Railway; 18, Birkenhead, Lancashire, and Cheshire Junction Railway; 19, Wells and

Fakenham Railway; 20, St. George's Harbour Acts Amendment; 21, Cowes and Newport (Isle of Wight) Railway; 22, Londonderry and Lough Swilly Railway; 23, Isle of Wight Ferry Company; 24, Charleston Railway and Harbour; 25, Dundalk and Enniskillen Railway; 26, Isle of Wight Railway (Eastern Section); 27, Chester and Holyhead Railway; 28, Malden and Sheen Valley Drainage;) — Admiralty Reports.
33. Bills—Superannuation (Amended).
37. „ Adulteration of Food or Drink.
44. „ Roman Catholic Oath.
38. „ Conveyance of Voters.
45. „ Law of Property and Trustees Relief Amendment.
42. „ Masters and Operatives.
43. „ High Sheriff Expenses.
22. „ Bankruptcy and Insolvency.

Delivered on 1st March, 1859.

47. Education—Return.
62. Lighthouses—Return.
86. Bankruptcy (Scotland)—Report of the Accountant.
88. Shipping—Returns.
46. Bill—Trial by Jury (Scotland).
48. „ Manor Courts, &c. (Ireland)—Amended.

Delivered on 2nd March, 1859.

60. Irish Reproductive Loan Fund—Account.
80. Harbour, &c. Bills (1. Falmouth Docks and Harbour)—Board of Trade Report.
89. Committee of Selection—2nd Report.
91. Lighthouses—Copy of the Royal Commission.
53. Criminals (Scotland)—Return.
6. Railway and Canal Bills (79, Belfast and Londonderry Junction Railway; 81, Brecon and Merthyr Tydfil Junction Railway; 82, Breconshire Railway and Canal (No. 1); 83, Charleston Railway and Harbour; 84, Cowes and Newport (Isle of Wight) Railway; 85, Dundalk and Enniskillen Railway; 86, Findhorn Railway; 87, Gateshead Quay; 88, Gloucester and Cheltenham Tramway Abandonment; 89, Hereford and Brecon Railway; 90, Holywood and Bangor Railway; 91, Llynvi Valley Railway; 92, Londonderry and Coleraine Railway; 93, Midland Great Western Railway of Ireland (Cavan to Clones, &c.); 94, Midland Great Western Railway of Ireland (Sligo Extension); 95, Mountsorrel Railway; 96, North Western Railway of Ireland; 97, Portsmouth and London and South Western Railway; 98, Ringwood, Christchurch, and Bournemouth Railway; 99, Sevenoaks Railway; 100, Silverdale and Newcastle-under-Lyme Railway; 101, South Staffordshire Railway; 102, Stokes Bay Railway and Pier; 103, Swanage Railway and Pier; 104, Tralee and Killarney Railway; 105, Victoria Station and Pimlico Railway; 106, Wansbeck Railway; 107, Witney Railway (No. 2); 108, Worcester and Hereford Railway—Board of Trade Reports.
39. Bills—Manslaughter.
47. „ Recreation Grounds.
49. „ Representation of the People.

Delivered on 3rd March, 1859.

87. Post Office—Copies of Letter and Treasury Minute.
90. Army Grants (deficiency for the year 1857-8)—Statement.
93. Funded Debt, &c.—Return.
96. Re-committal of Prisoners—Return.
97. Navy (Men voted 1815 to 1858-9)—Return.

PATENT LAW AMENDMENT ACT.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

[*From Gazette, March* 25, 1859.]

Dated 8th February, 1859.

350. J. Hosking, Walworth common, Surrey—Imp. in the manufacture of lamps.

Dated 24th February, 1859.

498. H. B. Barlow, Manchester—Imp. in apparatus for condensing steam. (A com.)

Dated 2nd March, 1859.

546. J. T. Carter, Belfast—Imp. in machinery for crushing, bruising, and preparing flax, hemp, and other fibrous materials requiring such treatment.

Dated 9th March, 1859.

609. J. Pilbrow, Tottenham, Middlesex—Certain imp. in, or a new method or methods of obtaining and applying motive power, a modification of which is also applicable for pumping or forcing liquids, gases, and fluids, as also for measuring liquids, gases, and fluids.
611. Sir W. G. Armstrong, Newcastle-upon-Tyne—Imp. in rifled ordnance and its projectiles.
613. J. Erwood, 132, Goswell-street, Clerkenwell, and J. Skertchly, Ashby de-la-Zouch, Leicestershire—Imp. in the manufacture of glass, sand, and emery papers and cloths, and other similar articles used for like purposes.
615. J. S. Russell, Great George-street, Westminster—Imp. in building ships and other vessels.
617. A. V. Newton, 66, Chancery-lane—Improved machinery for rolling horse shoe iron. (A com.)
619. H. Fisher, Birkenhead—Imp. in machinery or apparatus for cutting thin sheets of metal into strips, and for tempering sheets or strips of metal.

Dated 10th March, 1859.

621. J. Yuill, Glasgow—Imp. in saddle trees.
623. H. Lodge, Liverpool—Improved means of protecting ships, batteries, and other constructions or buildings from the effects of projectiles of various kinds.

Dated 11th March, 1859.

625. J. C. Haddan, 4, Cannon-row, Westminster—Imp. in casting mortars and cannon.
627. S. Wheatcroft, Brudenell-place, New North-road—Imp. in the construction of goffering and rouching machines in order to render them self-registering and self-indicating.
629. F. Clarke, Norland-square, Middlesex—An improved mode of and apparatus for cutting, drying, and preparing peat to be used as fuel, or for other purposes for which it may be usefully employed.

Dated 12th March, 1859.

631. J. Cunliffe and F. Piggott, Manchester, and G. Mallinson, Salford—Imp. in the manufacture of ornamental woven fabrics.
633. W. E. Newton, 66, Chancery-lane—Imp. in the manufacture of shoes and other coverings for the feet. (A com.)
635. J. T. Calow, Staveley, Derbyshire—A compound action in cage machinery, with the apparatus connected therewith, having a perforated shield for saving life and property in the event of a rope, band, or chain breaking, or the engine man drawing the cage too high at coal or other shafts, where slides are applicable, which said invention is also applicable to hoisting or other lifting machines.
637. J. Court, Brompton-row, Middlesex—An imp. in nibs for gas burners.
639. J. Macnab, Linlithgow, N.B.—Imp. in telegraphing or signalling apparatus.

Dated 14th March, 1859.

641. R. A. Brooman, 166, Fleet-street—An improved method of treating wool and other fibres in order to form threads. (A com.)
643. T. Lightfoot, Accrington, Lancashire—Imp. in fixing colours on woven fabrics or fibrous materials.
645. C. H. Hurst, Victoria-terrace, Royal-road, Kennington-park—An improved wrench or spanner.
647. T. Patstone, Birmingham—Imp. in shades or glasses, for gas and other lamps, and in the supports of the said shades or glasses.

Dated 15th March, 1859.

649. W. Langton, 14, Wharf, Belvidere-road, Lambeth—Imp. in the manufacture of keys and wood fastenings used in constructing railways.
651. G. B. Galloway, Newcastle-on-Tyne—Imp. upon, and in connection with, his former patents, and in the manufacture of fuel, and working steam engines more economically.
653. W. Clark, 53, Chancery-lane—Imp. in the apparatus of electric lamps or lights. (A com.)

INVENTIONS WITH COMPLETE SPECIFICATIONS FILED.

656. G. Seymour, 6, Golden-square, Regent-street—Imp. in making refined sugar, and making potash and soda from the residues. (A com.)—16th March, 1859.
667. J. Harris, junr., Massachusetts, U.S.—A new and useful or improved carpet sweeper.—16th March, 1859.

WEEKLY LIST OF PATENTS SEALED.

[*From Gazette, March* 25, 1859.]

March 25th.

2161. W. Lander.
2169. J. Manning and T. Paul.
2173. T. Britt.
2216. M. Jacoby and F. Rainford.
2224. D. Scattergood and R. W. Smith.
2242. T. Roberts and J. Dale.
2272. W. Johnston and W. Ross.
2280. Robert Ridley.
2306. G. T. Bousfield.
2326. A. W. Drayson and C. R. Binney.
2338. J. Grant.
2343. R. Griffiths.
2365. C. Clay.
2487. W. Ziervogel.
224. R. Rodmer.
325. J. M. E. Masson.

[*From Gazette, March* 29, 1859.]

March 18th.

2174. J. Wright.
2193. J. Rogers.
2233. Louis A. Normandy.
2269. J. F. Swinburn.
2271. T. C. Shaw.
2291. T. Ingram.
2308. L. Marcus.
493. Emile Alcan.
2809. M. A. F. Mennons.
221. W. Tasker.

PATENTS ON WHICH THE STAMP DUTY OF £50 HAS BEEN PAID.

[*From Gazette, March* 25, 1859.]

March 21st.

677. J. H. Johnson.
680. H. Brierly.

March 22nd.

678. J. Jones and A. C. Shirreff.
708. G. H. Cottam and H. R. Cottam.
720. T. B. Daft.
740. W. F. Thomas.
788. W. Roberts.
904. D. Lloyd.

March 23rd.

692. James Robertson.
705. W. Foster.

[*From Gazette, March* 29, 1859.]

March 24th.

739. C. J. Dumèry.
765. A. Guido.
809. F. W. Kitson.
850. A. C. L. Devaux.

March 26th.

747. J. Harrison.
749. J. Harrison.